

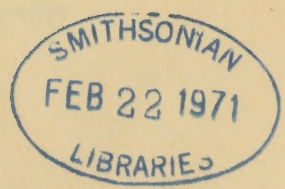




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THE SYSTEMATICS OF THE FISHES
OF THE FAMILY CLINIDAE
IN SOUTH AFRICA

By
MARY-LOUISE PENRITH

Cape Town Kaapstad



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By

MARY-LOUISE PENRITH

South African Museum, Cape Town

(With 48 figures)

[MS. received 24 September 1967]

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INTRODUCTION

The family Clinidae includes the klipfishes, which are characteristic of the intertidal pools of the South African coast. Most of the common shore fish species of the Cape Province belong to this family, which is widely distributed, with endemic species in each region where it occurs. The relationships between the clinids of different parts of the world, their zoogeography and possible origins are important in indicating wider faunal relationships and paths along which faunal dispersal may have taken place.

The present work is a taxonomic revision of the South African Clinidae. The species were previously split into two groups. The species contained in one of the groups did appear to be more closely related to each other than to any of the species in the other group, but the second group seemed to be a heterogeneous assemblage of species with little in common. Furthermore, the characters used in defining numerous genera were such as sometimes to create difficulties in the placing of undescribed species. The generic arrangement proposed in the present work is based largely on external characters and may change, pending more detailed osteological studies. It was felt, however, that at this stage some rearrangement of previous classifications was necessary, and that a publication containing figures and uniform descriptions of all the species presently recognized, and all information known of the distribution of those species, would form a useful basis for future work.

I

Since 1962 the South African Museum has carried out intensive collecting of intertidal fishes from Moçamedes in southern Angola to Durban. This has supplied large quantities of material of the common species so that the extent of variability of characters in those species could be determined, and additional material of the rarer species has been collected. This has enabled me to examine fresh (as well as preserved) material of 28 of the 33 species of Clinidae described below.

RELATIONSHIPS AND CLASSIFICATION OF THE FAMILY CLINIDAE

The Clinidae are a family of blennioid fishes. The blennioid fishes have been defined by Gosline (1968) as perciform teleosts with the pelvic fins anterior to the pectorals, and the number of dorsal and posterior soft anal rays corresponding exactly with the number of vertebrae between them. The caudal fin is usually rounded.

The limits of the suborder Blennioidei have been subject to much change by systematists during the last century. The definitive recent work of Gosline (1968) has established the position of the Blennioidei among the perciform fishes, and the limits of the suborder. Other recent reviews of the classification of blennioid fishes have been published by Hubbs (1952), who revised the classification of tropical blennioids, and Makushok (1958), who revised the northern blennioids. The families at present recognized as constituting the suborder Blennioidei are listed in the comprehensive classification of fishes by Greenwood *et al.* (1966), and also by Gosline (1968).

Family **CLINIDAE**

Diagnosis. Small, weakly-swimming blennioid fishes. Body usually covered with cycloid scales. Suborbital bony ring weak and flexible. Jaw teeth conical and fixed, usually in more than one series; vomerine teeth usually present, and sometimes palatine teeth as well. Lateral line canals on head covered; lateral line running in upper half of body in front to behind pectoral fin, then curving down fairly sharply to mid-lateral position. Dorsal fin long, more or less continuous; first three spines may be separated to varying degree from rest of fin; more spinous than soft elements. Anal fin long and continuous, with two spines anteriorly. Pelvic fins with minute spine and two to four rays, jugular in position. Dorsal, anal, pectoral, and pelvic rays unbranched. Caudal rays branched or simple. Pseudobranchiae present. Gill membranes united, forming fold across throat. Branchiostegal rays six to seven on either side. An upturned, hook-like process on anterior border of cleithrum present or not.

Distribution. The Clinidae are distributed along both coasts of North, Central and South America, the West Indies, West Africa, South and South West Africa, Australia, New Zealand, the East Indies, Japan, the Philippines, and the Mediterranean. Their greatest representation is in America, the West

Indies and the temperate waters of South Africa and Australia. They generally occur in the intertidal zone of the shore or on coral reefs.

Relationships. The work of Hubbs (1952), Makushok (1958), Ford (1959), and Gosline (1968) confirms the close relationship of the Clinidae, Tripterygiidae, and Blenniidae. Their relationship with other perciform fishes is as yet undetermined (Gosline, 1968; Springer, 1968). The only clinid and blennioid fossils known are from the Mediterranean Miocene, during which period the genera known today were probably differentiated. Hubbs (1952) considered that the Blenniidae diverged early from the other families, since the absence of scales and the position of the eyes, well forward and high up in the head, indicate that they have specialized along different lines from the Clinidae and the Tripterygiidae, and presumably must have required a considerable amount of time to perfect these specializations. The fossil family Pterygocephalidae, known only from Eocene deposits, shows a mixture of percoid and blennioid features, and evidently represents a very early line, but Hubbs (1952) stated that the Pterygocephalidae show certain specializations that would remove them from the direct line of descent of any of the modern blennioids.

Both the Clinidae and the Tripterygiidae have retained more generalized features than the Blenniidae, but neither can be said with certainty to be more primitive than the other. The usually compressed body of the Clinidae is more typically percoid than the usually depressed body of the Tripterygiidae, but the Tripterygiidae retain more branched fin rays than do the Clinidae, in which branched caudal rays appear in only a few of the apparently most primitive members of the family. The Clinidae and the Tripterygiidae have more in common with each other than either family has with the Blenniidae, and in the vast majority of earlier works have been treated as a single family. However, Hubbs (1952), in his key to the families he included in a superfamily Blennioidae, gave some of the features on which the families can be separated, and they have been treated as separate by later workers, in particular Rosenblatt (e.g. 1963).

A fairly strong link between the Clinidae and the Blenniidae appears to be the family Chaenopsidae, which has long been of uncertain position in blennioid classification. It has usually been either partially or completely submerged in the Clinidae or the Blenniidae. Stephens (1963), revising the Chaenopsidae, gave them family status. Springer (1964), reviewing Stephens's work, was not entirely satisfied that the characters on which Stephens raised the Chaenopsidae to family status justified such an action. They have features in some ways intermediate between those of the Clinidae and those of the Blenniidae; they lack scales, but their affinities appear on the whole to lie more with the Clinidae than with the Blenniidae (Böhlke, 1957). Springer (1966) continued to treat them as a separate family in his discussion of *Medusablennius chani*, and they are listed as a separate family in the classifications of Greenwood *et al.* (1966) and Gosline (1968).

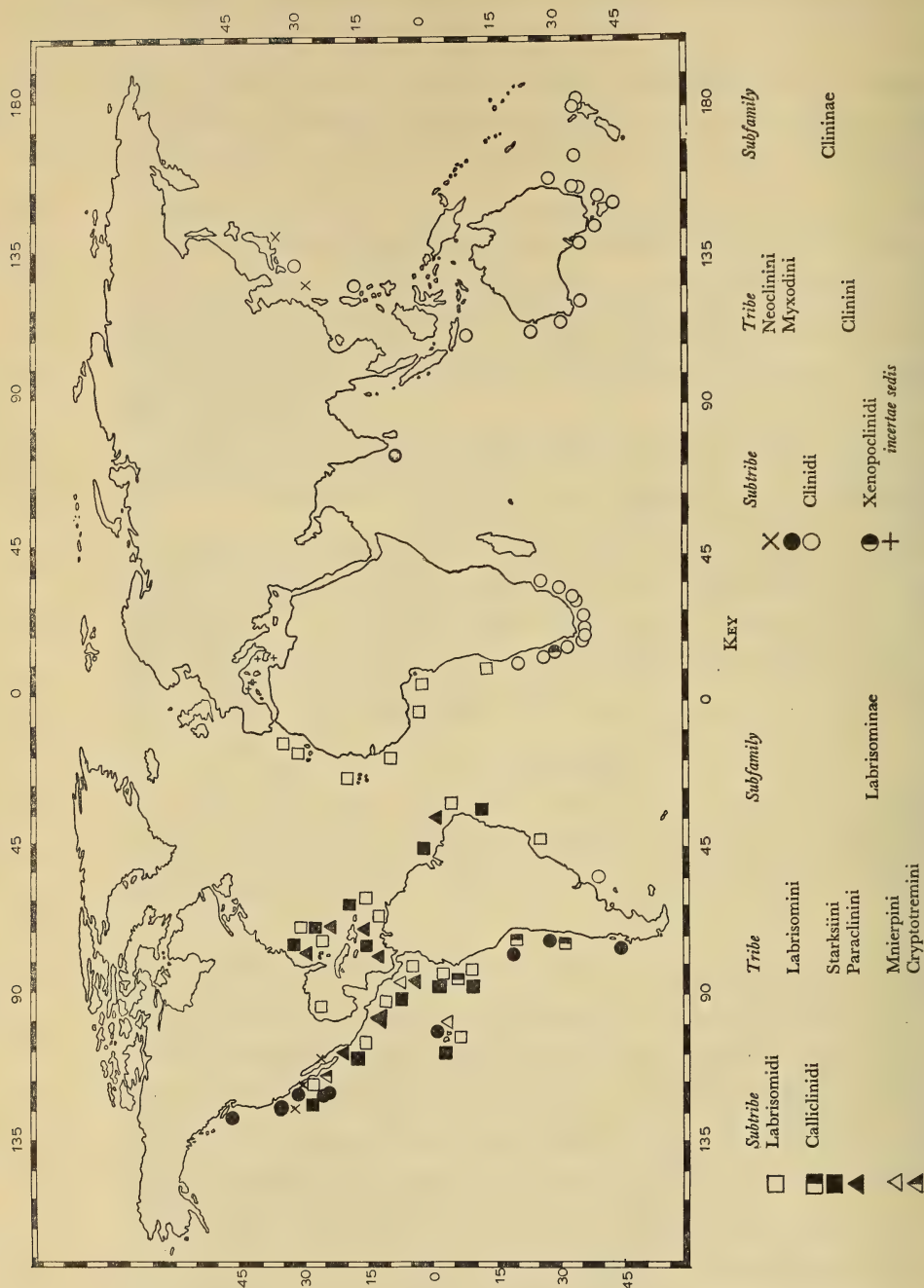


FIG. 1. World distribution of the tribes and subtribes of the family Clinidae.

Based mainly on the works of Al-Uthman, 1960; Delfin, 1898-1901; Griffin, 1926; Herc, 1939; Hubbs, 1952, 1953a, b; Jordan & Starks, 1906; McCulloch, 1908, 1929; McLeay, 1882; Scott, 1935, 1939, 1955; Smith, 1949; Springer, 1954, 1955, 1958; and South African Museum and British Museum records. With additional records from the following works: Beaufort & Chapman, 1951; Beebe & Tee-Van, 1928, 1934; Berg, 1898; Buen, 1962; Cadenat, 1950; Caldwell, 1954; Dawson, 1960; Evermann & Marsh, 1900; Fowler, 1931, 1942, 1944, 1947, 1950, 1953; Garman, 1899; Gilbert, 1900; Herc, 1936; Hildebrand, 1946; Klausewitz, 1958; Marshall, 1957; McCulloch, 1915, 1922; Mead, 1958; Metzelaar, 1922; Morrow, 1957; Ogilby, 1886; Olsen, 1958; Parr, 1930; Rosenblatt & Walker, 1963; Schultz, 1949; Smith, 1957; Starks, 1913; Stephens, 1961; Suzuki, 1964; Whitley, 1929, 1945, 1956, 1959.

The relationships within the family Clinidae are not by any means fully determined. Hubbs (1952) discussed the relationships of the South African and American Clinidae, but did not include the Australasian, Japanese, and Mediterranean clinids in his scheme of classification. He divided the Clinidae into two subfamilies, the Labrisominae and the Clininae. The Clininae are distinguished from the Labrisominae by the presence of an upturned hooklike process on the anterior border of the cleithrum. This process is absent in the vast majority of the Labrisominae, although in two labrisominid species, *Mala-coctenus erdmani* Smith and *M. aurolineatus* Smith, the hook is usually present in adults (Springer, 1958). The Clininae are further distinguished by the presence of radii on all scale margins. The scales are usually smaller than those of the Labrisominae (although exceptional genera without scales occur in both subfamilies), and the scales are often embedded in the skin.

The Labrisominae occur mainly in the tropical waters of both the Pacific and the Atlantic American coasts and the West Indies, one species occurs in Japan, and two species occur in tropical West Africa. The Clininae occur mainly in the temperate waters of the west coast of America, South Africa, and Australia, with a few representatives in New Zealand, two in Argentina, and one in Japan and the Philippines, and the East Indies.

Hubbs (1952) divided the Clininae into two tribes, the Clinidi and the Myxodidi. It should be noted here that Hubbs used the suffix -idi for tribes and the suffix -ini for subtribes, but in order to comply with the recommendation of the International Code for Zoological Nomenclature (1961), the process is reversed here and henceforth in the present work -ini will denote tribes and -idi will denote subtribes. Hubbs considered the Myxodini to be the more primitive group, since they are all oviparous, and the male lacks a penis for the transmission of sperm to the female. All the American Clininae belong to this tribe. The Clinini are distinguished by the presence in the male of a fleshy penis, and the fact that the young are born alive in at least all the species whose breeding habits are definitely known. All the South African clinids belong to the Clinini. Hubbs (1952) did not mention the Australian clinids and the Japanese clinine in his system of classification. Milward (1967) recognized three genera of Clinidae from Australia, of which two, *Cristiceps* and *Petraites*, are represented in western Australia. Milward found all the western Australian species, at least, to be live-bearing and to have an intromittent organ in the male. The Australian Clinidae of the genera *Clinus*, *Petraites*, and *Cristiceps* are here included in the tribe Clinini. The Japanese species, *Petraites flammeus* (Jordan & Starks, 1906), is referable to the Clinini, as it has a well-marked hook on the cleithrum (Jordan & Starks, 1906), and a delicate intromittent organ in the male (Dr. V. G. Springer, pers. comm.). The classification of the family Clinidae is shown in table 1. Their world distribution is shown in figure 1.

Two of the known species of Clinidae do not fit into Hubbs's scheme of classification. *Clinitrachus argentatus* (Risso), the Mediterranean clinid, must for the time being be regarded as *incertae sedis*. It lacks a hooklike projection on the anterior border of the cleithrum, and is oviparous, the male lacking a penis.

TABLE 1. Classification of the family Clinidae (main arrangement after Hubbs, 1952, 1953*a*; naming of certain genera modified according to Springer, 1955, and Böhlke & Springer, 1961; classification of the tribe Clinini new).

Family: **CLINIDAE** Regan, 1912

Subfamily: **LABRISOMINAE** Hubbs, 1952

Tribe: **NEOCLININI** Hubbs, 1953

NEOCLINUS Girard, 1858

Tribe: **MNIERPINI** Hubbs, 1952

MNIERPES Jordan & Evermann, 1896;

DIALOMMUS Gilbert, 1891

Tribe: **PARACLININI** Hubbs, 1952

STATHMONOTUS Bean, 1885; PARACLINUS Mocquard, 1889;

EXERPES Jordan & Evermann, 1896.

Tribe: **STARKSIINI** Hubbs, 1952

STARKSIA Jordan & Evermann, 1896

Tribe: **CRYPTOTREMINI** Hubbs, 1952

ALLOCLINUS C.L. Hubbs, 1927; CRYPTOTREMA Gilbert, 1890.

Tribe: **LABRISOMINI** Hubbs, 1952

Subtribe: **CALLICLINIDI** Hubbs, 1952

AUCHENIONCHUS Gill, 1860; CALLICLINUS Gill, 1860;

MYERSICHTHYS Hubbs, 1952

Subtribe: **LABRISOMIDI** Hubbs, 1952

LABRISOMUS Swainson, 1839; MALACOTENUS Gill, 1860

Subfamily: **CLININAE** Gill, 1885

Tribe: **MYXODINI** Hubbs, 1952

MYXODES Cuvier, 1829; HETEROSTICHUS Girard, 1854; GIBBONSIA Cooper, 1864.

Tribe: **CLININI** Hubbs, 1952

Subtribe: **CLINIDI** Hubbs, 1952

CLINUS Cuvier, 1817; PAVOCLINUS Smith, 1945; CLINOPORUS Barnard, 1927; GYNUTOCLINUS Smith, 1945; BLENNIOCLINUS Gill, 1860; ?PETRAITES Ogilby, 1886; CRISTICEPS Valenciennes in Cuvier & Valenciennes, 1836.

Subtribe: **XENOPOCLINIDI** Hubbs, 1952

XENOPOCLINUS Smith, 1947; CANCELLOXUS Smith, 1961.

Guilte (1893) stated that although Valenciennes (*in* Cuvier & Valenciennes, 1836) believed that further examination of this species would result in the male being found to have a penis, his detailed examination of many specimens revealed no such structure, the anal papilla always being small. He described the breeding of this species in some detail; the female lays her eggs among the fronds of algae before they are fertilized by the male. By the present definition of the group, the lack of a hook on the cleithrum excludes it from either tribe of the Clininae, yet it more closely resembles the Clininae than the Labrisominae, particularly in the nature of the small embedded scales. It is possible that, during the long isolation of this species from other members of the Clininae, the hook on the cleithrum may have been secondarily lost; or that this species separated from the line leading to the Clininae before the hook had appeared.

Clinus nematopterus Günther was described from the Sea of China in 1861. Mr. A. Wheeler of the British Museum of Natural History has kindly examined the type for me. It fits into the Clininae, having small, embedded scales, a hook on the anterior border of the pectoral girdle, and a penis. It is known from a single specimen. Dr. V. G. Springer (pers. comm.) suggests that it is probably the same as the Japanese and Philippine clinids.

Of the three genera of Clinidae recognized in Australia (Milward, 1967), *Cristiceps* is a well-defined genus occurring mainly or only in the Australian region. Two Argentinian species of Clinidae, *eigenmanni* Jordan, 1887 and *argentinus* Berg, 1898, were placed in the genus *Cristiceps* by their original authors. The descriptions are both very brief, but various points in them suggest that these two South American species may not be referable to the same genus as the Australian *Cristiceps*. However, they are provisionally treated as Clinini in figure 1.

The Australian species of *Clinus* and *Petraites* that I have examined are externally at least very similar to one another and to the South African species of the genus *Clinus*. Both genera have been used for South African and Australian Clinidae. The validity of the genus *Petraites* is doubtful. Ogilby (1886) created the genus *Petraites* to contain certain Australian species. McCulloch (1908) said that *Petraites* cannot be clearly separated from *Clinus*, as there are several intermediate forms, but surprisingly went on to say that 'no good purpose can be served by uniting the two genera'. It seems unlikely that any good purpose is served by retaining as separate two genera that are difficult to distinguish from one another. However, a wider range of Australian material than has at present been available to me would be necessary to determine whether the genus *Clinus* should include both Australian and South African species, and whether there is any justification for retaining the genus *Petraites*. The Japanese *flammeus* may belong to an Australian genus or may warrant a genus of its own.

SYSTEMATICS OF THE SOUTH AFRICAN CLINIDAE

Material and methods. Most of this study is based on the clinid material in the South African Museum collection. The collection was considerably augmented

during my study by additions of fresh material collected on the coast from Swakopmund in South West Africa to Durban. Rotenone poison and hand-nets were used in the collection of samples. Details of material examined are given under the description of each species.

Where a syntype series is present in the South African Museum collection, a specimen in good condition and agreeing with the original description has been selected and designated as a lectotype.

Measurements were made with needle-point dividers as follows: Standard length (tip of snout to mid-base of caudal fin); head length (tip of snout to upper extremity of opercle); depth at anal origin; greatest diameter of orbit; length of upper jaw (inner edge of premaxilla to upper end of maxilla); length of caudal peduncle (base of last anal ray to mid-base of caudal fin); least depth of caudal peduncle; height of first dorsal spine; height of fourth dorsal spine; length of portion of fourth dorsal spine free from fin membrane. Head length was expressed as the number of times the head was contained in the standard length, as was body depth, and orbit diameter as the number of times it was contained in the head length, since these measurements were so expressed by

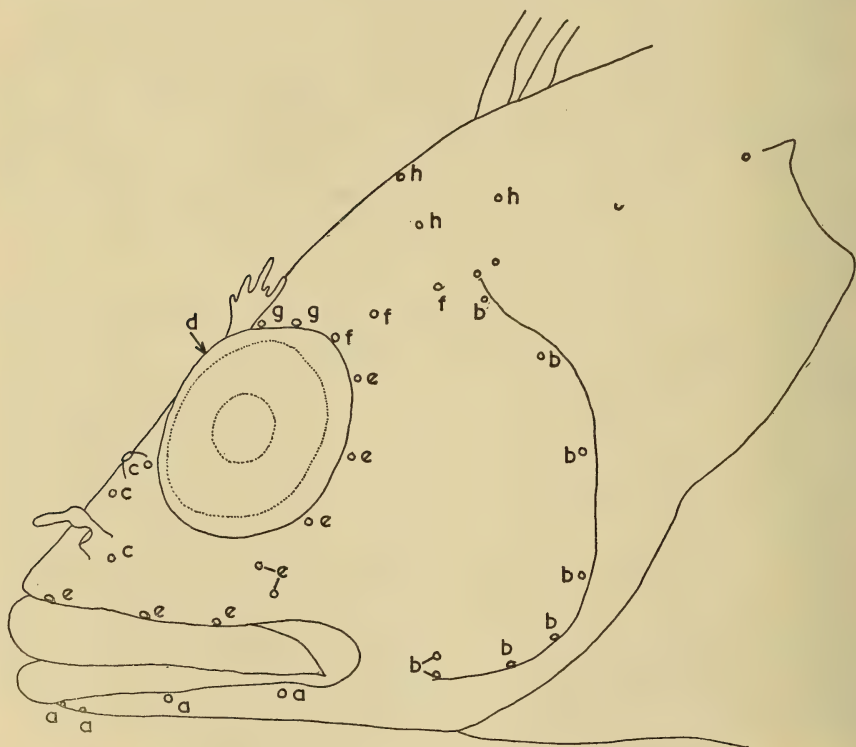


FIG. 2. Disposition of head pore series.

a = mandibular; b = preopercular; c = nasal; d = interorbital; e = suborbital;
f = postorbital; g = supraorbital; h = occipital.

previous authors; other measurements were expressed as percentage of standard length or of head length. Head length, body depth, orbit diameter, and caudal peduncle measurements are given under each description; other measurements are given where relevant. Counts were made of the number of spines and rays in the dorsal, anal, pectoral and pelvic fins, by the usual methods; all the fin rays in all South African Clinidae are undivided. Counts given in parentheses are modal counts. Vertebral counts of small samples of each species were made from X-ray photographs. Caudal vertebrae were taken to be those which had a haemal spine. Counts of the gill-rakers of the outer series on the first arch are given where possible. The disposition of the head pore series referred to is shown in figure 2.

Abbreviations used in the lists of material given at the end of each species description are S.A.M. (South African Museum) and R.U.C. (Department of Ichthyology, Rhodes University, Grahamstown).

The localities referred to in the distribution notes for each species are shown in a map, figure 48, placed at the end of the paper for easy reference.

Subfamily CLININAE Gill, 1885

Diagnosis. Clinidae with an upturned, hook-like process on the anterior edge of the cleithrum. Scales usually small and embedded, with radii on all margins. Caudal rays always unbranched. No nuchal cirri.

Tribe CLININI Hubbs, 1952

Diagnosis. Clininae which bear their young alive. Males with a fleshy penis. Always a cirrus above the anterior nostril. Body scales usually small and embedded, exceptionally absent. Hook on cleithrum usually well developed, rarely reduced or absent.

Subtribe CLINIDI Hubbs, 1952

Diagnosis. Clinini with head compressed, eyes lateral. Pelvic rays free from membrane for greater part of length. Hook on anterior border of cleithrum well developed.

Historical discussion of the classification of the South African Clinini

Various attempts have been made to classify the South African Clinini. Valenciennes (*in* Cuvier & Valenciennes, 1836), who described many of the species, placed all the South African species that he described, as well as *Blennius superciliosus* Linnaeus, in the genus *Clinus* Cuvier, with the exception of *capensis*, for which Cuvier (1817) had erected the genus *Cirrhibarbis*, distinguished from *Clinus* by the presence of barbels on the chin and snout.

Swainson (1839) erected various genera of Clinidae, besides recognizing Cuvier's genera *Clinus* and *Cirrhibarbis*. Besides those two genera, three of Swainson's genera (*Clinitrachus*, *Blennophis*, and *Labrisomus*) contained South

African species. He used body form and form of the dorsal fin (whether raised anteriorly to form a crest or not), as well as dentition, in the definition of his genera. He included two South African species, *latipennis* Valenciennes and *brachycephalus* Valenciennes (= *linearis* Swainson) in the genus *Labrisomus*, whose representatives are now included in a different subfamily from the South African forms (table 1).

Gill (1860) discussed Swainson's division of Cuvier's genus *Clinus*. He regarded *Clinus* and *Clinitrachus* as congeneric, as he considered the presence or absence of a dorsal crest to be insufficient grounds for generic separation, but *Blennophis* he considered valid. He removed from the genus *Labrisomus* most of the species placed in it by Swainson (1839), including *latipennis* and *brachycephalus*, erecting the genera *Ophthalmolophus* for the former and *Blennioclinus* for the latter. He stated that, while *latipennis* and *brachycephalus* were related, the former could be distinguished by the presence of supraorbital tentacles.

Swain (1882), in reviewing Swainson's (1839) work, followed Gill (1860) in synonymising *Clinitrachus* with *Clinus*, and considered *Blennophis* and *Labrisomus* to be subgenera of *Clinus*. He made little attempt to sort out exactly which species should be placed in each genus or subgenus, being chiefly concerned with the validity or otherwise of Swainson's proposed generic names.

The earlier South African workers, Gilchrist & Thompson (1908) and Barnard (1927), disregarded most of the clinid genera then available, and placed the majority of the South African species in the genus *Clinus* as defined by Cuvier (1817). Gilchrist & Thompson (1908) placed one species, *mentalis* Gilchrist & Thompson, in the genus *Cristiceps* Valenciennes on account of its completely separate dorsal crest. Several of the other species, notably *mus* Gilchrist & Thompson and *laurentii* Gilchrist & Thompson, also with completely separate dorsal crests and otherwise rather similar to *mentalis*, were retained in the genus *Clinus*. *Cristiceps* is an Australian genus with distinctive characters not found in any of the South African species. In their introductory discussion, Gilchrist & Thompson (1908: 98) also suggested that the generic name *Clinoides* be used for the non-crested species, but did not use the name in their systematic discussions.

Barnard (1927) transferred *mentalis* to another Australian genus, *Petraites* Ogilby, and with it *laurentii*, but *Petraites* is characterized by the presence of a supraorbital tentacle, lacking in both *mentalis* and *laurentii*. Barnard (1927) also described a new genus, *Clinoporus*, for *Clinus biporosus* Gilchrist & Thompson, which lacks scales and has a peculiar lateral line very different from that of the other clinids. In 1935 he described the species *navalis* and placed it in a new genus *Climacoporus*, based on lateral line differences.

Smith (1945) revised the South African Clinidae and divided the group into two subfamilies (Clininae and Myxodinae), distinguished only by the presence or absence of a supraorbital tentacle. Among the 15 genera, seven of them monospecific, which he recognized, nine were old genera: *Clinus*, *Cirrhibarbis*, *Blennophis*, *Ophthalmolophus*, *Petraites*, *Blennioclinus*, *Clinoporus*,

Climacoporus, and *Myxodes* Cuvier. Of these *Myxodes* had been used previously only for South American species; the inclusion in it by Smith of the South African live-bearing species *fuorum* Gilchrist & Thompson was later pointed out to be an error (Hubbs, 1952). In addition to the above genera, Smith described six new genera: *Muraenoclinus*, *Blenniomimus*, *Fucomimus*, *Pavoclinus*, *Labroclinus*, and *Gynutoclinus*, four of which are monospecific.

Hubbs (1952), in a revision of the higher taxonomic categories of the Clinidae, accepted Smith's (1945) division of the South African species, but reduced Smith's subfamilies to the level of subtribes of the Clinini, which includes all the South African species (see table 1). Hubbs named them the 'Clinini' and the 'Blennioclinini', any form of the name *Myxodes* being unacceptable for South African species. He pointed out that the South African species *fuorum*, which Smith placed in the genus *Myxodes* on dental characters, could not be a *Myxodes* on account of the penis in the male and the fact that the young are born alive. Hubbs created a new genus, *Smithichthys*, for *fuorum*, revived Swainson's (1839) genus *Clinitrachus* for the species *superciliosus* Linnaeus and *robustus* Gilchrist & Thompson, and used the name *Clinus* for the species placed by Smith (1945) in the genus *Ophthalmolophus*. Apart from the changes in the nomenclature of the genera and the lowering of the two subfamilies to the status of subtribes, he did nothing to alter Smith's system of classification.

Smith (1966) pointed out that the genus *Clinitrachus* is applicable to the oviparous Mediterranean clinid *argentatus* Risso by type designation by Swainson (1839), and created a new genus, *Caboclinus*, for *superciliosus* and *robustus*.

From the above it can be seen that the only definitive attempt to group the South African Clinidae above the species level was Smith's (1945) revision. The major objection to this classification is his union of the non-tentacled species into one group. The genera *Blennioclinus*, *Gynutoclinus*, and *Clinoporus* have little in common with the other 'Blennioclinini' or with each other apart from the lack of a supraorbital tentacle in all except *Gynutoclinus*, which has a supraorbital papilla.

A potentially useful contribution to South African clinid taxonomy was made by Jackson (1950), but this unfortunately has remained unpublished, in thesis form. Jackson examined the South African Clinidae and concluded that to separate groups of species at a higher level than the generic one was incorrect. He placed the species with a supraorbital tentacle in one genus, *Clinus*, having the subgenera *Clinus*, *Blennophis*, *Petraites*, *Ophthalmolophus*, *Cirrhibarbis* and *Climacoporus*. Most of the species lacking a supraorbital tentacle he placed in another genus, *Myxodes* (this work was, of course, done prior to Hubbs' 1952 study), having subgenera *Myxodes*, *Blennioclinus* and *Labroclinus*. He left *Clinoporus* and *Gynutoclinus*, both monospecific and rare, with full generic value, mainly (he stated) owing to lack of material for study.

Jackson's scheme is one which, with several important modifications, appears to me to give a more valid interpretation of the evolutionary history of the group than any of the others. He distinguished his genera *Clinus* and

Myxodes on the presence or absence of a supraorbital tentacle and the relative size of the mouth. *Clinus* was defined as having a tentacle over the eye and a large mouth with powerful jaws, while *Myxodes* lacked a supraorbital tentacle and had a small mouth with weak, narrow jaws.

I have made measurements of the upper jaw of samples of all the South African species of Clinini, and the results are shown in a diagram (figure 3). The statistical method used in preparing the diagram was that described by Hubbs (1952); details of the method are given in the legend to the figure.

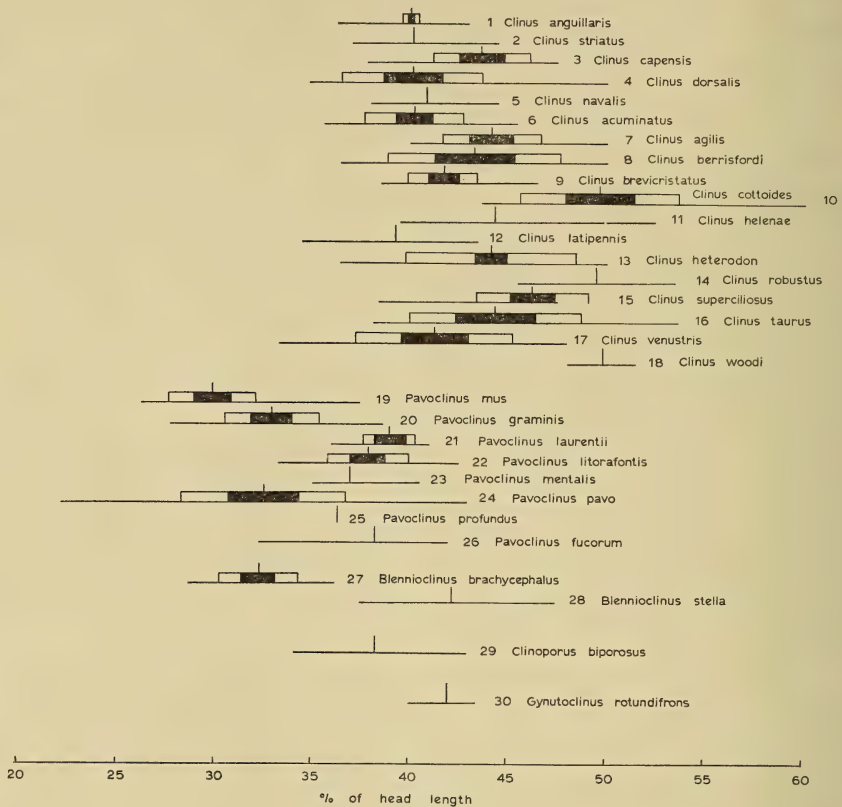


FIG. 3. Comparison of upper jaw lengths of the South African species of Clinini.

The method of representation is that used by Hubbs (1952) for comparative morphological studies. In each diagram the base line represents the range of measurements recorded for the sample, the upright line represents the mean, the open area represents the standard deviation on either side of the mean, and the solid area represents two standard errors on either side of the mean.

Samples of 25 specimens covering the full size range available were used where possible. Where fewer than 25 specimens were available, all specimens were used. For species of which fewer than 10 specimens were available, only the range and the mean are given. A full set of data is given in Appendix A.

All the species that have a fringed supraorbital tentacle (numbers 1–18 in figure 3) have an upper jaw averaging more than 40% of the head length in the specimens examined (which usually covered a reasonably wide size range). Most of the species included in Jackson's *Myxodes* (numbers 19–28 in figure 3) have the upper jaw averaging less than 40% of the head length. However, the difference between the lower limits of the ranges of one group and the upper limits of the ranges of the other group is to my mind too small to be of much use as a definitive generic character; the overlap would render determination difficult in the case of individual specimens. There is clearly a tendency for the species with fringed supraorbital tentacles (genus *Clinus*) to have larger mouths than most of the other species, and this is certainly of importance in uniting the group, although it would apparently be of little use in placing individuals in one group or the other.

Jackson suggested that ecological considerations should be taken into account in attempting to classify the South African Clinidae. He stated that, while his *Clinus* species frequented rocky crevices and stony pools, his *Myxodes* species lived in seaweed. All the species that he included in *Myxodes* other than those belonging to his subgenus *Blennioclinus* do live in seaweed, and are modified in body form and colour for this habitat. However, *Clinus brevicristatus* Gilchrist & Thompson, a rare tentacled clinid not different from the other species of *Clinus* in body form or type of colour pattern, is usually taken in seaweed together with the seaweed dwellers of Jackson's genus *Myxodes*. The occurrence of *C. brevicristatus* in seaweed, as well as other tentacled clinids on occasions, indicates that the habitat in which any individual specimen may have been collected is not necessarily an indication of its relationships. However, the suggestion by Inger (1958) that species united by resemblance and phylogenetic considerations will usually be adapted for the same type of habitat is in general true of the South African Clinidae.

There are relatively few characters that can be used to differentiate between the South African members of the Clinini above the species level, since this group is fairly homogeneous in most respects, and many features are common to the group as a whole. I have divided the group into five genera, somewhat unevenly, on external characters. Two are large genera, containing between them 26 of the 30 recognized species of Clinidi. Subgenera have been used in these two genera to denote pairs or groups of species which appear to be more closely related to each other than to the other species in the genus. Of the other three genera, two are monospecific and rare, and the third contains two species. The five genera are compared in table 2.

Key to the genera of the South African Clinidi

- | | |
|--|-------------------|
| 1. Body covered with small scales | 2 |
| Body without scales | <i>Clinoporus</i> |
| 2. A tentacle or minute papilla over the eye | 3 |
| No tentacle or papilla over the eye | 4 |

- | | | | | | | | |
|----|---|----|----|----|----|----|----------------------|
| 3. | A minute, simple papilla over the eye | .. | .. | .. | .. | .. | <i>Cynutoclinus</i> |
| | A fringed or branched tentacle over the eye | .. | .. | .. | .. | .. | <i>Clinus</i> |
| 4. | Posteriormost dorsal spine much shorter than first dorsal soft ray; a deep notch in the margin of the dorsal fin before the soft rays | .. | .. | .. | .. | .. | <i>Blennioclinus</i> |
| | Posteriormost dorsal spine almost equal to first dorsal soft ray; no deep notch in the margin of the dorsal fin before the soft rays | .. | .. | .. | .. | .. | <i>Pavoclinus</i> |

Genus CLINUS Cuvier, 1817

- Clinus* Cuvier, 1817: 173 (type-species *Blennius acuminatus* Bloch & Schneider, by subsequent designation by Swainson, 1839: 75).
Cirrhibarbis Cuvier, 1817: 174 (type-species *Cirrhibarbis capensis* Valenciennes in Cuvier & Valenciennes, by monotypy).
Blennophis Swainson, 1839: 75 (type-species *Clinus anguillaris* Valenciennes in Cuvier & Valenciennes, by monotypy).
Ophthalmolophus Gill, 1860: 104 (type-species *Clinus latipennis* Valenciennes in Cuvier & Valenciennes, by monotypy).
Climacoporus Barnard, 1935: 646 (type-species *Climacoporus navalis* Barnard, by monotypy).
Muraenoclinus Smith, 1945: 538 (type-species *Clinus dorsalis* Castelnau, by monotypy).
Blenniominus Smith, 1945: 538 (type-species *Clinus taurus* Gilchrist & Thompson, by original designation).
Caboclinus Smith, 1966: 73 (type-species *Clinus robustus* Gilchrist & Thompson, by original designation).

Diagnosis. A distally flattened, at least bifid tentacle over eye. Lateral line usually of double pores and/or single pores opening above and below line anteriorly; posterior to post-pectoral curve usually of short separate horizontal tubes with a pore at either end. Intromittent organ of male usually consists of fairly long basal portion with small tip retractile between one or two pairs of fleshy lips. Body covered with small embedded cycloid scales. Two bands of villiform teeth in each jaw, outer row larger. Vomer always toothed. Upper jaw averages more than 40% head length. Body moderately robust. Caudal peduncle short.

Note on the type-species of Clinus

The problem of the type-species of *Clinus* is discussed by Hubbs (1952) and Smith (1966). *Blennius superciliosus* Linnaeus was generally regarded as the type-species of the genus, and was so designated by Swain (1882), because it is evident from the expanded description of the genus by Valenciennes (*in* Cuvier & Valenciennes, 1836) that the description was based chiefly on specimens of *superciliosus*. However, Swainson's (1839) arbitrary designation of *acuminatus* Bloch & Schneider as the type-species of *Clinus* must stand according to the rules of the International Code of Zoological Nomenclature (1961), Article 69(a)(iii).

Discussion

Most of the 18 species of the genus *Clinus* are small and occur almost exclusively in the intertidal zone; a few extend into deeper water, and a few reach a fairly large size (150–350 mm). Most species live in rock-pools among

TABLE 2. Comparison of the South African genera of Clinidi.

	<i>Clinus</i>	<i>Paoclinus</i>	<i>Blennioclinus</i>	<i>Clinoporus</i>	<i>Gynutoclinus</i>
Characters					
Supraorbital tentacle	Distally flattened and branched	Absent	Absent	Absent	Minute, simple papilla
Scales	Small or minute, sometimes overlapping	Small or minute, often overlapping	Minute, not overlapping	Absent	Minute, not overlapping
Lateral line	Anterior pores often double; if single, opening above or below; posterior part usually of short horizontal tubes with pore at each end	Anterior pores single, opening medially or above and below; posterior part of short horizontal tubes with pore at each end	Anterior pores double; posterior part of short horizontal tubes with pore at each end.	Pores very large opening above or below irregularly throughout	Anterior pores single opening medially; posterior part of short horizontal tubes with pore at each end.
Intromitent organ	Basal part moderate to long; tip usually small, ensheathed or not	Basal part small to moderate; tip large, protruding	Basal part short to moderate; tip long, slender, ensheathed	Basal part long; tip small, not ensheathed	Basal part long; tip small, ensheathed
Upper jaw	Averages more than 40% head length	Averages less than 40% head length	30-45% head length	Less than 40% head length	More than 40% head length
Body form	Moderate to robust, sometimes eel-like	Moderate to highly compressed	Moderate	Robust, eel-like	Highly compressed
Clusters of cirri on dorsal spines	Often present	Absent	Present	Absent	Absent
Last dorsal spine/first dorsal ray	About equal	About equal	Much shorter	About equal	About equal
Translucent 'windowns' in fin membranes	Usually absent	Present	Absent	Absent	Present
Caudal peduncle	Short	Moderate/long	Short	Short	Short
Mucus pores on head	Open flush or on papillae	Open flush	Open flush	Open flush	Open on papillae

stones and in crevices, although many species frequently hunt in sea-weeds as well, and one species habitually occurs in beds of the green alga *Caulerpa*; none, however, are particularly modified or coloured for weed-dwelling (see *Pavoclinus*). They are well camouflaged and able to change colour and pattern almost instantaneously, although there is generally a basic pattern of pigmentation that may last for a considerable time after preservation. This pattern may be of blotches or cross-bars, and there is almost invariably an ocellate spot on the shoulder, anterior fin spines, or opercle. The species are entirely carnivorous, but the diet is very varied, both between and within species. There is a tendency in many species to develop a notch in the membrane joining the third and fourth dorsal spines. The first three dorsal spines are often elevated to form a crest; this is considered to be a primitive feature in the family Clinidae (Hubbs, 1953b). In *C. superciliosus*, which has a very well developed crest, the height of the crest shows sexual dimorphism. The other species show little or no sexual dimorphism other than the development of a penis in the male.

An examination of the gonads of many individuals of several species of this genus suggests that, while parasitism of the ovaries by trematodes occurs to a varying degree, the testes of the males are normally not affected.

Jackson (1950) divided *Clinus* into subgenera which, with one exception, corresponded with Smith's (1945) genera. In attempting to group the 18 species contained in the genus *Clinus* as defined above, one is confronted with the difficulty of deciding on a method that will reflect the natural relationships of the species within the genus. This is a problem, because there is an indication of development along at least two major and several minor lines within the genus. Most of the species form a more or less generalized group in which each minor line of development is represented by a range rather than a cluster of species.

It is proposed to use five subgenera, one of which contains a large number of generalized species. The other four are believed to represent particular lines of development and are easily defined; they appear to be more closely related to each other than to the more generalized species.

Clinus navalis, *C. dorsalis*, *C. anguillaris*, *C. striatus*, and *C. capensis*, previously distributed among the genera *Climacoporus*, *Muraenoclinus*, *Blennophis*, and *Cirrhibarbis* are all rather elongate, eel-like species. Smith (1945) separated them from each other generically for the following reasons: (1) *Clinus navalis* has only one dorsal soft ray, and the lateral line pores are double for most of the length of the line, sometimes the whole length; it was placed in the genus *Climacoporus* by Barnard (1935) and retained in that genus by Smith (1945). (2) *C. dorsalis* has only one dorsal soft ray, and the lateral line is of the usual type posterior to the post-pectoral curve (i.e. of short horizontal tubes with a pore at either end); Smith (1945) placed it alone in the genus *Muraenoclinus*. (3) *C. anguillaris* and *C. striatus* have 2-4 dorsal soft rays and scaly cheeks, and were placed in the genus *Blennophis*. (4) *C. capensis* has barbels on the chin and snout, and scaly cheeks, and was placed in the genus *Cirrhibarbis*.

C. anguillaris and *C. striatus* are the two most eel-like species. They have small scales on the cheeks as well as on the bases of the dorsal, anal and caudal fins. They are very alike and form a distinct pair of species; it is proposed to show their relationship by placing them together in a subgenus *Blennophis*.

C. capensis cannot be confused with any other species, on account of the barbels on the chin and snout. In some families, e.g. Brotulidae, this feature is considered sufficient grounds for generic distinction. Springer (1954) included one species with a chin barbel in the clinid genus *Paraclinus*, whose members are otherwise without facial barbels. In view of the fact that *C. capensis* resembles

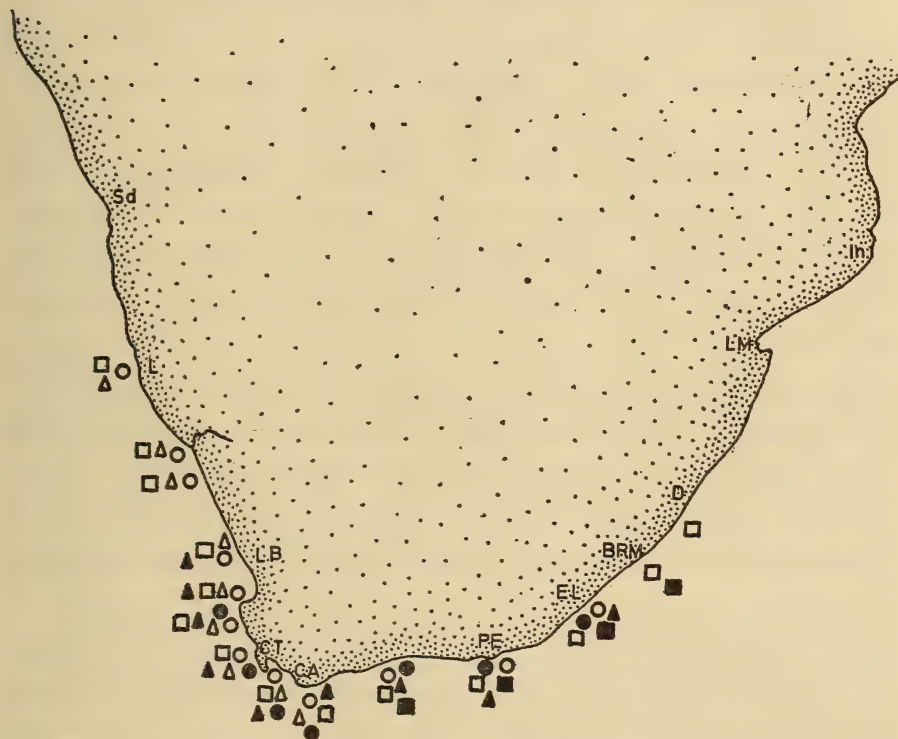


FIG. 4. Distribution of *C. anguillaris* (open circles), *C. striatus* (closed circles), *C. capensis* (closed triangles), *C. dorsalis* (open squares), *C. navalis* (closed squares), *C. acuminatus* (open triangles).

the other species of *Clinus* in all other respects, having the same type of supra-orbital tentacle, lateral line, and intromittent organ, it seems preferable to treat this species as a member of the genus *Clinus*. Since, however, it is set apart from the others by the facial barbels, it may be placed in a subgenus *Cirrhibarbis*.

The lateral line of *C. navalis* appears to be of the same type as that found in the other species of *Clinus*, but the pores continue double for a varying distance behind the post-pectoral curve, often along the whole length of the lateral line.

As in *C. dorsalis*, there is one soft ray in the dorsal fin, and the cheeks are naked, as in the majority of species. The supraorbital tentacle is similar in *C. navalis* and *C. dorsalis*. It is very difficult to distinguish between juvenile specimens of these two species except on fin counts. However, since *C. dorsalis* differs from *C. navalis* in being a far more elongate species, with 19 precaudal vertebrae as opposed to 15 in *C. navalis*, and has virtually all the sensory pores of the head and lateral line system single, while in *C. navalis* most of the sensory pores are double, and finally, in view of the unusual form of the intromittent organ in *C. navalis*, *Muraenoclinus* and *Climacoporus* are maintained as subgenera.

The remaining 13 species constitute the subgenus *Clinus*.

C. taurus and *C. cottoides* were placed in a genus *Blenniomimus* by Smith (1945) because both species have a bony ridge over the eye, which makes the interorbital appear concave instead of flat. The ridge is by no means striking in small specimens of *C. cottoides*; and it is slightly developed in *C. latipennis* and *C. helenae*, which Smith placed in the genus *Ophthalmolophus*. *C. taurus* and *C. cottoides* should therefore not be separated generically or even subgenerically from the other species, since they, particularly *C. taurus*, represent the extreme of the range of development of a particular feature. The bony ridge is furthermore a feature which in some species becomes more pronounced with age; in *C. heterodon* there is no sign of a ridge in small specimens, but it may be very pronounced in large ones.

C. superciliosus, *C. robustus*, *C. brevicristatus* and *C. woodi* were previously separated from the other tentacled species because the first three dorsal spines were higher than the succeeding ones, forming a crest. *C. superciliosus* and *C. robustus* were placed in the genus *Clinus* in a restricted sense, because they have a notch in the membrane between the third and fourth dorsal spines less than 50% of the height of the fourth spine. The two species were subsequently transferred first to *Clinitrachus*, by Hubbs (1952), and then to *Caboclinus*, by Smith (1966).

C. brevicristatus and *C. woodi* were placed in the genus *Petraites*. Species of this genus have a notch in the fin membrane between the third and fourth dorsal spines more than 50% of the length of the fourth spine (McCulloch, 1908), although Smith (1945) stated that the notch is complete in *Petraites*, and the membrane from the third spine barely reaches the base of the fourth spine. McCulloch (1908) stated that the two genera *Clinus* and *Petraites* are barely distinguishable from one another, and this is certainly true of the South African species involved, since *C. superciliosus* resembles *C. woodi* more closely than it does *C. robustus*, and *C. brevicristatus* is as close to forms such as *C. agilis*, *C. venustis*, and *C. cottoides* as it is to *C. woodi*. In *C. superciliosus* the depth of the notch varies from 0–100% of the fourth spine, but is generally 40–60% (see table 3). *C. robustus* has an extremely shallow notch. In *C. woodi* the membrane from the third spine barely reaches the base of the fourth spine. In *C. brevicristatus* the notch varies from 25–100% of the fourth spine but is usually 50–75%, and only rarely 100%. The crest is high and triangular in *C. woodi* and

particularly in mature male specimens of *C. superciliosus*, and is very low, scarcely elevated, in *C. robustus* and *C. brevicristatus*. Among the other species, *C. agilis* and *C. taurus* have a notch in the membrane between the third and fourth spines but the first three spines are not elevated, and *C. venustis* often has the second and third dorsal spines somewhat elevated. There is a range of crest and notch development in this genus, and it is thus impossible to base generic distinctions on these features. It is often difficult to decide whether individual specimens of *C. robustus* and *C. brevicristatus* have a crest at all, while in other individuals it is quite marked. It is also possible that the crest has been developed or reduced separately in the various species, and that its presence does not indicate close affinity. There are no other features to suggest a closer affinity amongst all the crested species than amongst crested and non-crested species.

The five species previously contained in the genus *Ophthalmolophus* were apparently placed there because they lacked any of the structures that distinguished the other genera, although in fact indications of those structures appear in the various members of this group of species. As noted above, *C. latipennis* and *C. helenae* show signs of a bony ridge over the eye, and may in that feature represent stages approaching the condition seen in *C. taurus* and *C. cottoides*, so that the classification should in some way relate these species. *C. agilis*, with a notch between the third and fourth dorsal spines, is too similar to *C. brevicristatus* on the one hand, with a deeper notch and the first three dorsal spines slightly elevated, and to species such as *C. acuminatus* on the other hand, with no notch or crest, to be separated even subgenerically from either. *C. venustis* shows rudiments of a crest (the second and third dorsal spines are sometimes higher than the others), but this is not sufficiently marked in every individual for the species to be defined as having a crest. Apart from these variations of the dorsal fin, the 13 species placed in the subgenus *Clinus* are united by so many common features and are often so hard to distinguish from one another that any attempt at separation into subgenera would be unwarranted.

I believe that while the subgenera used do represent different lines of evolution within the genus *Clinus*, the species contained in the genus as a whole form a well-defined group that are more closely related to each other than to any other clinid species. However, should another worker wish to separate the eel-like subgenera *Blennophis*, *Cirrhibarbis*, *Muraenoclinus* and *Climacoporus* from the subgenus *Clinus* and place them in a separate genus or separate genera, there would be little reason for serious objection to such an arrangement.

Distribution of the genus Clinus

In South Africa *Clinus* occurs in temperate waters. Three species (*C. navalis*, *C. helenae*, *C. woodi*) are confined to the waters north-east of Cape Agulhas; most of the species are restricted to the coast south of the Kei River (figs 4, 11, 19). Only one species (*C. woodi*) is known to extend north of Durban to Inhambane, where it is rare, and it does not reach the tropical waters north of that point. On the north-west coast, two species (*C. superciliosus* and *C. heterodon*) extend

into the tropics north of Walvis Bay, but as the coast in that region is under the influence of the cold Benguela current, conditions of water temperature and fauna are not markedly tropical. The genus *Clinus* includes all the common species of the Cape coast west of the Cape Peninsula. Twelve of the 18 species have been recorded from the waters west of Cape Point, only one of these (*C. cottoides*) being common north-east of Algoa Bay. The other five species are fairly rare throughout the South African coastal region. It seems that this genus has its greatest distribution in the colder regions of the South African coast.

Range. Rocky Point (18°59'S., 12°29'E) (South West Africa) to Inhambane (23°51'S., 35°29'E) (Mozambique).

Key to the subgenera of Clinus

- | | | |
|----|--|-------------------------------|
| 1. | Scales on the cheeks | 2 |
| | No scales on the cheeks | 3 |
| 2. | Barbels on chin and snout | <i>Cirrhibarbis</i> |
| | | (1 species, <i>capensis</i>) |
| | No barbels on chin or snout | <i>Blennophis</i> |
| | | (2 species) |
| 3. | One dorsal soft ray | 4 |
| | More than one dorsal soft ray | <i>Clinus</i> |
| | | (13 species) |
| 4. | More than 40 dorsal spines; most sensory pores single | <i>Muraenoclinus</i> |
| | | (1 species, <i>dorsalis</i>) |
| | Fewer than 40 dorsal spines; most sensory pores double | <i>Climacoporus</i> |
| | | (1 species, <i>navalis</i>) |

Subgenus *Blennophis* Swainson, 1839

Blennophis Swainson, 1839: 75 (type-species *Clinus anguillaris* Valenciennes in Cuvier & Valenciennes)

Diagnosis. Elongate eel-like clinids with small scales on cheek and dorsal, anal and caudal fin bases, as well as over general body surface. Body robust. Dorsal fin low, even. No cirri at dorsal spine tips. No barbels on chin or snout. Dorsal soft rays 2-4.

Remarks. Two species, one common only west of Cape Point, the other rare throughout its range, but encountered more frequently east of Cape Point. Both reach a large size and occur infratidally as well as in intertidal rock pools.

Key to the species of Blennophis

- | | | |
|----|--|---|
| 1. | Inner pelvic ray stout, equal in length to other two; dorsal spines 46 or more, anal rays 33 or more | <i>Clinus</i> |
| | | (<i>Blennophis</i>) <i>anguillaris</i> |
| | Inner (third) pelvic ray minute or absent; dorsal spines 45 or fewer, anal rays 31 or fewer | <i>Clinus</i> (<i>Blennophis</i>) <i>striatus</i> |

TABLE 3. Depth of notch in membrane between third and fourth dorsal spines (expressed as % of fourth dorsal spine free from membrane).
The numbers represent number of specimens from each sample having a particular depth of notch.

Species	0-9%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-99%	100%
<i>Clinus</i>											
<i>superciliatus</i>	3	0	3	12	15	40	57	19	16	2	7
<i>Clinus woodi</i>	0	0	0	0	0	0	0	0	0	0	5
<i>Clinus robustus</i>	1	0	2	2	1	1	0	0	0	0	0
<i>Clinus</i>											
<i>brevicristatus</i>	0	0	1	0	2	2	7	4	7	0	4
<i>Clinus agilis</i>	4	1	1	9	3	32	34	7	9	0	0
<i>Clinus taurus</i>	0	0	0	1	1	0	8	4	1	0	0

Clinus (Blennophis) anguillaris Valenciennes in
Cuvier & Valenciennes, 1836
(Fig. 5)

Blennius rubescens Lichtenstein, 1823: 117 (*nomen oblitum*).

Clinus anguillaris Valenciennes in Cuvier & Valenciennes, 1836: 390. Gilchrist & Thompson, 1908: 133. Barnard, 1927: 862.

Blennophis anguillaris: Swainson, 1839: 75. Smith, 1945: 539, 1949: 352, pl. 78 fig. 980.

Blennophis rubescens: Smith, 1962: 40.

Description. D. XLVI-L (XLVIII-L) 2-4 (3-4); A. II 33-37; P. 13-14 (13); V. I 3; C. 13. Gill-rakers in outer series on first arch 2-3 + 5-7. Vertebrae 18 + 38-40. Dorsal fin long, low, even. No clusters of cirri on dorsal spine tips. Pectoral fin rounded. Inner pelvic ray well developed, stout, equal to others. Caudal peduncle very short, length 15.5-25% head length, depth 28.5-35.5% head length. Caudal fin short, sub-truncate.

Body elongate, robust, eel-like, with small embedded scales extending on to caudal, dorsal, and anal fin bases, upper edge of opercle, and cheeks. Depth 6-7.75 in standard length. Head bluntly wedge-shaped, 4.75-5.75 in standard length. Eye 3.25-5 in head, relative size of eye decreasing with increase in

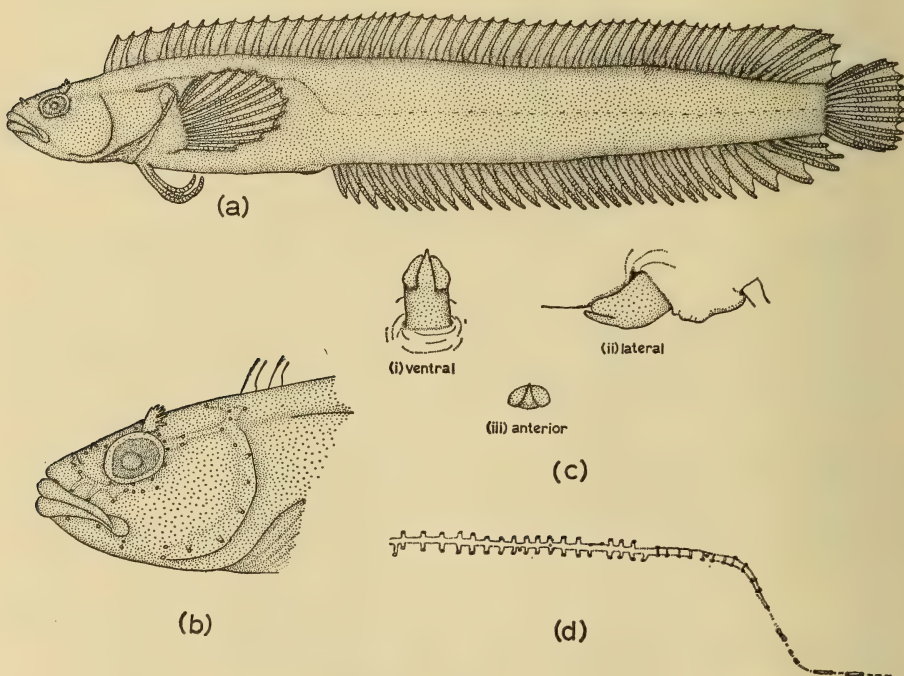


FIG. 5. *Clinus (Blennophis) anguillaris*: (a) Lateral view, male, 99 mm, S.A.M. 24206; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

standard length of fish. Orbital tentacle prominent, with flat stalk and fine fringe of cirri at tip. Cirrus on anterior nostril elongate, simple, with serrated edges. Upper jaw 38–42.5% head length. Lips thick. Vomer toothed. Sensory pores of head single in nasal, interorbital, occipital and supraorbital series, mainly single in mandibular and preopercular series, first pore of mandibular and last pore of preopercular series double; postorbital and suborbital series mostly of paired pores (fig. 5 (b)).

Lateral line mostly of vertical pairs of pores in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 5 (d)). Intromittent organ of male with moderate basal portion and single pair of oval dorso-lateral lips (fig. 5 (c)).

Colouring. Variable, reddish to dark maroon, or pink with reddish blotches. Fins red- or white-tipped. Sometimes light-edged, dark ocellus on shoulder, always present in juveniles. Often two dark radiating bars from eye across cheek. Snout white in large, dark-red specimens. Plain buff or pinkish preserved in alcohol.

Location of type material. Muséum National d'Histoire Naturelle, Paris.

Material examined. 36 specimens, 65–278 mm in standard length. 2 from 'Rade du Cap', Paris Museum Cat. Nos. A. 2079 & 6341 (syntypes); 11 from Lüderitzbucht, S.A.M. 24208; 1 from Gert du Toit Bay, southern Namaqualand, S.A.M. 24019; 4 from Doring Bay, southern Namaqualand, S.A.M. 24020; 2 from Lambert's Bay, S.A.M. 23887, S.A.M. 24010; 1 from Kommetjie, Cape Peninsula, S.A.M. 23874; 9 from St. James, False Bay, S.A.M. 10526, S.A.M. 13721; 2 from Dalebrook, False Bay, S.A.M. 21538, S.A.M. 21539; 1 from Still Bay, S.A.M. 25059; 1 from East London, S.A.M. 19745; 2, no locality, S.A.M. 21708, S.A.M. 21709.

Remarks. The scales on the head in this and the related species, *Clinus* (*Bleniophis*) *striatus*, might possibly be primitive characters, as also the degree of development of the inner pelvic ray of *C. anguillaris*.

Nomenclature. Smith (1962) pointed out that Lichtenstein's (1823) description of *Blennius rubescens* from the Cape of Good Hope fits *Clinus anguillaris*. However, the name *anguillaris* has been used for the present species since 1836, while Lichtenstein's name had not been used for well over a hundred years until Smith revived it in 1962. According to the International Code of Zoological Nomenclature (1961), Article 23(b), unless the International Commission should decide otherwise, 'a name that has remained unused as a senior synonym in the primary zoological literature for more than fifty years is considered to be a forgotten name (*nomen oblitum*)'. Forgotten names may not be used unless the Commission so directs. Smith (1962) did not place the matter before the Commission. The name *anguillaris* Valenciennes in Cuvier & Valenciennes, 1836, is thus retained for this species.

Distribution (fig. 4). The known range is Lüderitzbucht (26°38'S., 15°10'E) (South West Africa) to East London (33°00'S., 27°54'E). Fairly common on

the west coast as far south as Lambert's Bay, becoming rather rare east of Cape Point. Small specimens occur under stones in shallow pools near the top of the shore, but larger specimens occur only at the bottom of the shore, and extend into the sublittoral fringe. The species blends perfectly with the stipes of kelp among which it occurs.

Clinus (Blennophis) striatus Gilchrist & Thompson, 1908
(Fig. 6)

Clinus striatus Gilchrist & Thompson, 1908: 134. Barnard, 1927: 862.

Blennophis striatus: Smith, 1945: 539, 1949: 353, fig. 981.

Description. D. XL–XLV 2–4 (2–3); A. II 28–31 (30–31); P. 12–13 (13); V. I 2–3; C. 13. Gillrakers in outer series on first arch 2–3 + 7–8. Vertebrae 17 + 34–35. Dorsal fin long, low, even. No clusters of cirri at tips of dorsal spines. Pectoral fin rounded. Inner pelvic ray reduced or absent. Caudal peduncle very short, length 10–20% head length, depth 23–27% head length. Caudal fin short, subtruncate.

Body elongate, robust, eel-like, with small embedded scales extending on to caudal, dorsal and anal fin bases, upper edge of opercle, and cheeks. Depth 6–8.25 in standard length. Head bluntly wedge-shaped, 4.5–5.25 in standard length. Eye 3.5–5 in head. Supraorbital tentacle prominent, with flat stalk and fringe of fine cirri at tip. Cirrus on anterior nostril elongate, spatulate, and slightly lobed ventrally. Upper jaw 37–44.5% head length. Lips thick. Vomer toothed. Sensory pores of head single in nasal and interorbital series; mainly single in mandibular and preopercular series, first mandibular and last preopercular pore paired. Pores of other series double. Multiple pore in postorbital series (fig. 6(b)).

Lateral line as in *Clinus anguillaris*, mainly of vertical pairs of pores opening above and below line in front to post-pectoral curve, then of short, separate horizontal tubes with pore at either end (fig. 6(d)). Intromittent organ of male with moderate basal portion and single pair of narrow, crescentic dorso-lateral lips (fig. 6(c)).

Colouring. Pink with brownish-red to dark-red mottling, fins usually reddish. Adults occasionally have faint white longitudinal stripes. Light-edged dark ocellus on shoulder. Two dark radiating lines from eye across cheek. Juveniles white with longitudinal black stripes. Uniform buff to pinkish preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Female, 142 mm standard length, Simon's Bay, False Bay, S.A.M. 25239.

Material examined. 11 specimens, 42–145.5 mm in standard length. 1 from Saldanha Bay, S.A.M. 23878; 3 from Simon's Bay, False Bay, S.A.M. 25239 (lectotype), S.A.M. 10527 (paralectotypes), 2 from Kalk Bay, False Bay,

S.A.M. 17844, S.A.M. 18086; 3 from Strandfontein, False Bay, S.A.M. 24240; 2, no locality, S.A.M. 21710, S.A.M. 21796.

Remarks. This species is very similar to *Clinus anguillaris*, differing from it externally only in the fin counts, in the degree of reduction of the inner pelvic ray and in the greater number of double sensory pores on the head.

Distribution (fig. 4). The known range is from Saldanha Bay ($33^{\circ}00'S.$, $17^{\circ}56'E$) to East London ($33^{\circ}00'S.$, $27^{\circ}54'E$). The juveniles occur high up on the shore, but larger specimens are taken at the bottom of the shore and infratidally, among kelp stipes. Rare.

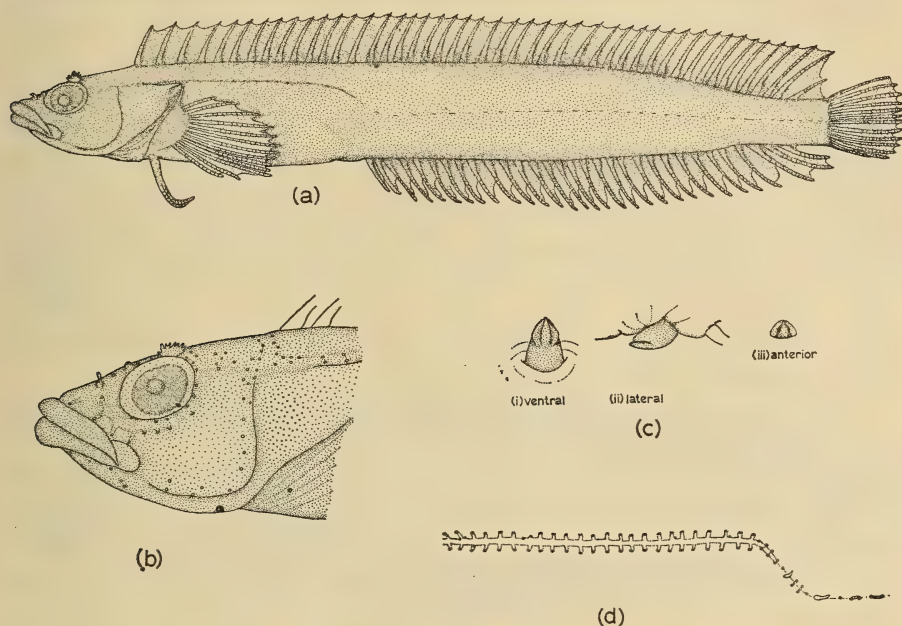


FIG. 6. *Clinus* (*Blennophis*) *striatus*: (a) Lateral view, female, 142 mm, S.A.M. 25239, lectotype; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Subgenus *Cirriharbis* Cuvier, 1817

Cirriharbis Cuvier, 1817: 174 (type-species *Cirriharbis capensis* Valenciennes in Cuvier & Valenciennes).

Diagnosis: Elongate clinids. Snout pointed, with three stout, simple cirri at tip; chin with eight stout, simple cirri. Small scales on cheek, dorsal, caudal and anal fin bases, as well as over general body surface. Dorsal fin low, even, with clusters of fine cirri at tips of spines.

One species, *Clinus* (*Cirriharbis*) *capensis* (Valenciennes in Cuvier & Valenciennes).

Clinus (Cirrhibarbis) capensis (Valenciennes in Cuvier & Valenciennes, 1836)

(Fig. 7)

Cirrhibarbis capensis Valenciennes in Cuvier & Valenciennes, 1836: 405. Swainson, 1839: 277 fig. 86. Smith, 1945: 539, 1949: 352, pl. 77 fig. 977, and fig. 977.

Clinus capensis: Günther, 1861: 269. Gilchrist & Thompson, 1908: 131. Barnard, 1927: 853.

Description. D. XXXVII-XLIV (XXXVIII-XLI) 5-9 (6); A. II 26-34 (26-29); P. 12-14 (13); V. I 2-3; C. 13. Gill-rakers in outer series on first arch 2-3 + 5-7. Vertebrae 18-21 + 32-37. Dorsal fin low, even. Clusters of 3-5 fine cirri at tips of dorsal spines. Pectoral fin rounded. Inner pelvic ray reduced, with free tip very short, or absent. Caudal peduncle short, length 20-30% head length, depth 18-26% head length. Caudal fin subtruncate.

Body elongate, slightly compressed, covered with small embedded scales extending on to dorsal, caudal and anal fin bases, and cheeks. Depth 5-6 in standard length, occasionally greater. Head narrow, pointed, 3.5-4.5 in standard length. Snout with three stout, simple cirri at tip; chin with eight stout, simple cirri clustered about jaw symphysis. Supraorbital tentacle prominent, with broad flat stalk and fringe of fine cirri at tip. Eye 3.5-5.5 in head. Cirrus on anterior nostril large, spatulate, with about four shallow, flat lobes at tip. Upper jaw 37.5-47.5% head length. Lips thick. Vomer toothed. Most of sensory pores of head double; multiple pores occur mainly in postorbital and occipital series (fig. 7(b)).

Lateral line of vertical pairs of pores in front to post-pectoral curve, then of short separate horizontal tubes with pore at each end (fig. 7(d)). Intromittent organ of male with long basal portion; pair of large confluent dorsal lips and pair of rounded ventral lips ensheathing tip (fig. 7(c)).

Colouring. Variable, pinkish, grey, or greenish mottled. Light-edged dark ocellus on shoulder. Fins and facial cirri usually red. A juvenile specimen from Lambert's Bay and two specimens from the west coast of the Cape Peninsula, one juvenile and one adult, were milky white with longitudinal black stripes and red fins and facial cirri. Buff to pinkish preserved in alcohol, shoulder spot may remain distinct.

Location of type material. Muséum National d'Histoire Naturelle, Paris.

Material examined. 97 specimens, 28-246 mm in standard length. 2 from Cape of Good Hope, Paris Museum Cat. Nos. 710, 6334 (syntypes); 1 from Lambert's Bay, S.A.M. 24237; 1 from Kommetjie, Cape Peninsula, S.A.M. 23926; 1 from Froggy Pond, False Bay, S.A.M. 23930; 2 from Kalk Bay, False Bay, S.A.M. 18224, S.A.M. 18276; 11 from Dalebrook, False Bay, 19/2/1965 and 18/4/1965, S.A.M. not catalogued; 14 from St. James, False Bay, S.A.M. 10530, S.A.M. 12018, S.A.M. 23583, and 1962, S.A.M. not catalogued; 29 from Strandfontein, False Bay, S.A.M. 23975, S.A.M. 24236; 1 from Gordon's Bay, False Bay, S.A.M. 23290; 4 from Onrust River Mouth, S.A.M. 24238; 10 from Still Bay,

S.A.M. 25098, S.A.M. 24665; 4 from Mossel Bay, S.A.M. 23929; 4 from Port Elizabeth, S.A.M. 23928; 2 from Igoda Mouth, East London, S.A.M. 25099; 8 from East London, S.A.M. 23927; 3 from Gonubie River Mouth, East London, S.A.M. 25100.

Remarks. This species can be distinguished at once from all other African clinid species by the facial cirri, but it is considered similar enough to the other tentacled species to be included in the genus *Clinus*. It is most similar to the eel-like forms of the subgenus *Blennophis* in body form, type of habitat, and the very short caudal peduncle, as well as the scaly cheeks; the clusters of cirri at the tips of the dorsal spines, the intromittent organ with its two pairs of lips and the high dorsal soft ray count are more similar to the conditions found in some of the species of the subgenus *Clinus*.

Distribution (fig. 4). The known range is Lambert's Bay ($32^{\circ}04'S.$, $18^{\circ}20'E$) to East London ($33^{\circ}00'S.$, $17^{\circ}56'E$). The source of Smith's (1949) Port Nolloth record for this species is not known, and in spite of extensive collecting there its occurrence has not been confirmed. It is rare west of Cape Point, but is fairly common from False Bay eastwards. It lives in shallow pools when small, but large adults appear to be more or less confined to the sublittoral fringe.

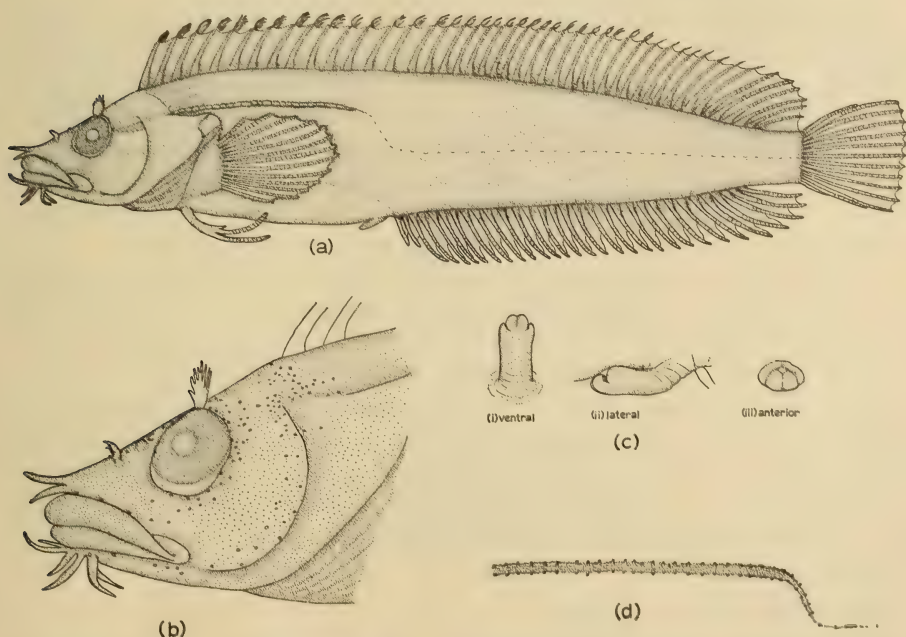


FIG. 7. *Clinus* (*Cirrhibarbis*) *capensis*: (a) Lateral view, male, 76 mm, S.A.M. 24236; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Subgenus *Muraenoclinus* Smith, 1945

Muraenoclinus Smith, 1945: 538 (type-species *Clinus dorsalis* Castelnau in Bleeker).

Diagnosis. Elongate clinids with one dorsal soft ray. No scales on cheeks. Dorsal fin low, even. No clusters of cirri at tips of dorsal spines. No barbels on chin or snout. Most sensory pores single. Posterior part of lateral line of short separate horizontal tubes with pore at either end.

One species, small and intertidal; fairly common on the west coast, less so eastwards to the south coast of Natal.

Clinus (Muraenoclinus) dorsalis Castelnau in Bleeker, 1860
(Fig. 8)

Clinus dorsalis Castelnau in Bleeker, 1860: 54. Castelnau, 1861: 54. Gilchrist & Thompson, 1908: 132. Barnard, 1927: 86.

Muraenoclinus dorsalis: Smith, 1945: 538, 1949: 352, pl. 78 fig. 979.

Description. D. XLI–XLVIII (XLV–XLVI) 1; A. II 25–31 (26–29); P. 11–13 (12); V I 2–3; C. 13. Gill-rakers in outer series on first arch 2 + 0–3. Vertebrae 19 + 32–35. Dorsal fin low, even. No clusters of cirri at dorsal spine tips. Pectoral fin rounded. Inner pelvic ray reduced, often absent, if present minute. Caudal peduncle very short, length 16.5–20% head length, depth 26–33.5% head length. Caudal fin short, subtruncate.

Body elongate, eel-like, slightly compressed, covered with small embedded scales not extending on to fin bases or head. Depth 5.5–7. Head narrowly wedge-shaped, snout acutely pointed, head 3.5–5 in standard length. Eye 3–4.5 in head. Supraorbital tentacle prominent, with flat stalk and terminal fringe of fine cirri. Cirrus on anterior nostril narrow at base, tip broadly spatulate, with deeply serrated edge. Upper jaw 34.5–46% head length. Lips thick. Vomer toothed. Sensory pores of head single in most series, last pore of preopercular series and most pores of suborbital series double (fig. 8(b)).

Lateral line of single pores opening above and below line in front to postpectoral curve, then of short separate horizontal tubes with pore at either end (fig. 8(d)). Intromittent organ of male with long basal portion; pair of dorso-lateral lips and pair of rounded ventral lips ensheathing tip (fig. 8(c)).

Colouring. Plain dark green or red, or light greenish or brownish mottled with darker greens, browns, and mauves. Mottled specimens have ocellate spot on shoulder. Broad white stripe from base of first dorsal spine to tip of snout. Fins same as general body colour. Juveniles usually uniform light brown or black with white stripe from dorsal origin to tip of snout. Plain yellowish buff preserved in alcohol.

Location of type material. Unknown.

Material examined. 138 specimens, 23–71.5 mm in standard length. 26 from Lüderitzbucht, S.A.M. 10535, S.A.M. 24207; 17 from Port Nolloth, S.A.M. 24222; 22 from Lambert's Bay, S.A.M. 23931; 3 from Saldanha Bay, S.A.M.

17913; 6 from Sea Point, S.A.M. 23932 and 17/2/1965, S.A.M. not catalogued; 14 from Kalk Bay, S.A.M. 10536; 2 from Dalebrook, False Bay, S.A.M. 24239 and 18/4/1965, S.A.M. not catalogued; 20 from St. James, False Bay, 1962, S.A.M. 23935; 1 from False Bay, S.A.M. 23934; 5 from Onrust River Mouth, S.A.M. 24258; 1 from Hermanus, S.A.M. 23933; 9 from Die Dam, Bredasdorp district, S.A.M. 24505; 3 from Still Bay, S.A.M. 18077 and April, 1965, S.A.M. not catalogued; 4 from Great Fish Point and East London, S.A.M. 18091; 4 from East London, S.A.M. 23936.

Remarks. *Clinus dorsalis* most closely resembles *Clinus navalis*. Jackson (1950) placed it in his subgenus *Blennophis* with *Clinus anguillaris* and *Clinus striatus*, but in view of the naked cheeks and the single soft dorsal ray it seems more appropriate to place it in a separate subgenus.

Note on the author of Clinus dorsalis

Gilchrist & Thompson (1908), Thompson (1918), Barnard (1927) and Smith (1945, 1949) gave Bleeker (1860) as the author of this species, but this appears to be incorrect. The first record of the species was published by Bleeker (1860), but it was listed as *Clinus dorsalis* Castelnau although Castelnau's description of the species was published a year later, in 1861. In a brief note

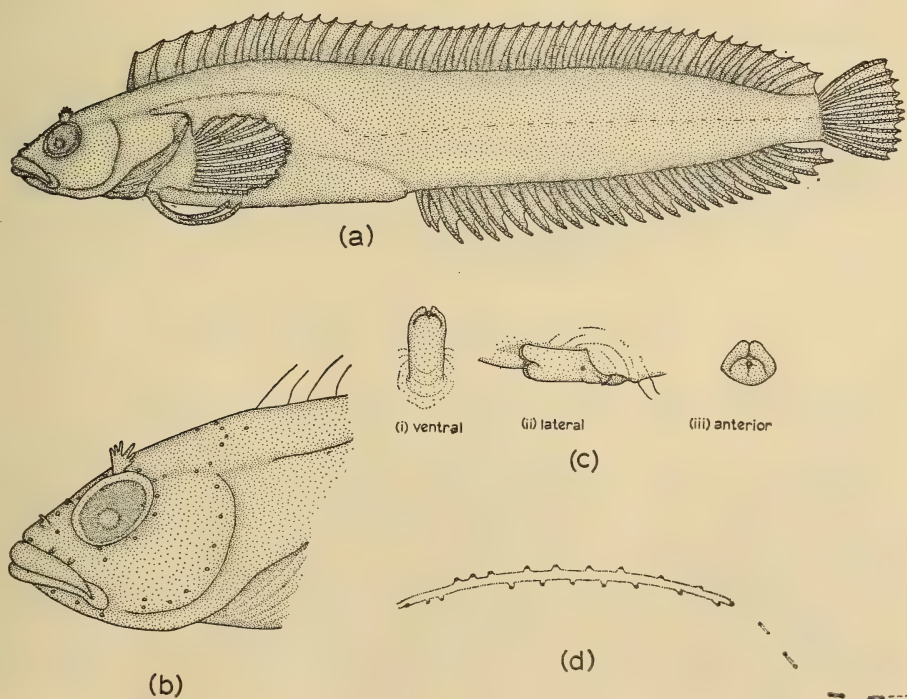


FIG. 8. *Clinus* (*Muraenoclinus*) *dorsalis*: (a) Lateral view, female, 64 mm, S.A.M. 24207; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

published in 1860 Castelnau discussed the fish fauna of South Africa and stated that he would be producing a memoir on the ichthyological fauna of southern Africa, in which 69 new species would be described. It seems probable that Bleeker saw and quoted from Castelnau's list of species prior to its publication in 1861. He should not be regarded as the author of the species, since he acknowledged Castelnau as the author, and the full description of the species was written and published by Castelnau.

Distribution (fig. 4). The known range of this species is Lüderitzbucht ($26^{\circ}38'S.$, $15^{\circ}10'E$) (South West Africa) to the Natal South Coast (Smith, 1947a). Smith (1937) gave the north-western limit of this species as Walvis Bay, stating that he took this record from Barnard (1927). However, Barnard (1927) gave the north-western limit as Angra Pequena (Lüderitzbucht), so that the 1937 Walvis Bay record was due to an error in transcription. The occurrence of the species north of Lüderitzbucht has not been confirmed.

Usually found among stones in shallow pools high on the shore, but occurs at all levels of the intertidal zone. This species appears to be more common west of Cape Agulhas.

Subgenus *Climacoporus* Barnard, 1935

Climacoporus Barnard, 1935: 646 (type-species *Climacoporus navalis* Barnard).

Nemacoclinus Smith, 1937: 195 (referring to *Climacoporus navalis* Barnard).

Diagnosis. Fairly elongate clinids with one dorsal soft ray. No scales on cheeks. Dorsal fin low, even. No clusters of cirri at tips of dorsal spines. No barbels on chin or snout. Most sensory pores double; vertical pairs of pores in posterior part of lateral line.

One species, small and intertidal, occurring only east of Cape Agulhas and rare.

Clinus (*Climacoporus*) *navalis* (Barnard, 1935) (Fig. 9)

Climacoporus navalis Barnard, 1935: 646. Smith, 1945: 538, 1949: 352, pl. 78 fig. 978.

Nemacoclinus navalis: Smith, 1937: 195.

Description. D. XXXV-XXXVIII 1; A. II 23; P. 12; V. I 2-3; C. 13. Gill-rakers in outer series on first arch 1-2 + 5. Vertebrae 15 + 27-29. Dorsal fin low, even. No clusters of cirri at tips of dorsal spines. Pectoral fin rounded. Inner (third) ray of pelvic fin reduced or absent. Caudal peduncle short, length 25-33.5% head length, depth 25-33.5% head length. Caudal fin subtruncate.

Body elongate, slightly compressed, covered with small, embedded, non-imblicating scales extending on to dorsal, caudal, and anal fin bases but not head. Depth 5-6.25. Head 4-5.25 in standard length, snout rounded. Eye 3-4 in head. Supraorbital tentacle prominent, with flat stalk and fringe of fine cirri terminally. Cirrus on anterior nostril small, flap-like, slightly emarginate

below apex. Upper jaw 38–44·5% head length. Lips thick. Vomer toothed. Sensory pores of head single in nasal, interorbital, and mandibular series, mainly double in all other series (fig. 9(b)).

Lateral line of vertical pairs of pores throughout; narrows and may become obscure towards tail (fig. 9(d)). Intromittent organ of male long, slender with apparently no definition into tip, basal part and lips (fig. 9(c)).

Colouring. Yellow-brown to greenish, mottled and barred irregularly with darker green or brown; head green or reddish brown; belly cream. Light-edged dark ocellus on shoulder. Plain buff preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Material examined. 10 specimens, 18–57 mm in standard length. 1 from ship's bottom, Simonstown, False Bay, S.A.M. 18287 (holotype); 2 from Still Bay, S.A.M. 25101; 1 from Port Elizabeth, S.A.M. 23889; 1 from Boknes Point, R.U.C.; 2 from Great Fish Point, R.U.C.; 1 from Igoda Mouth, East London, S.A.M. 25102; 2 from Xora Mouth, R.U.C.

Remarks. The arrangement of the double pores of the lateral line of this species is exactly the same as the arrangement seen in the anterior part of the lateral line of other species that have double pores, such as *Clinus capensis*. In view of the many features which *Clinus navalis* has in common with other species of the

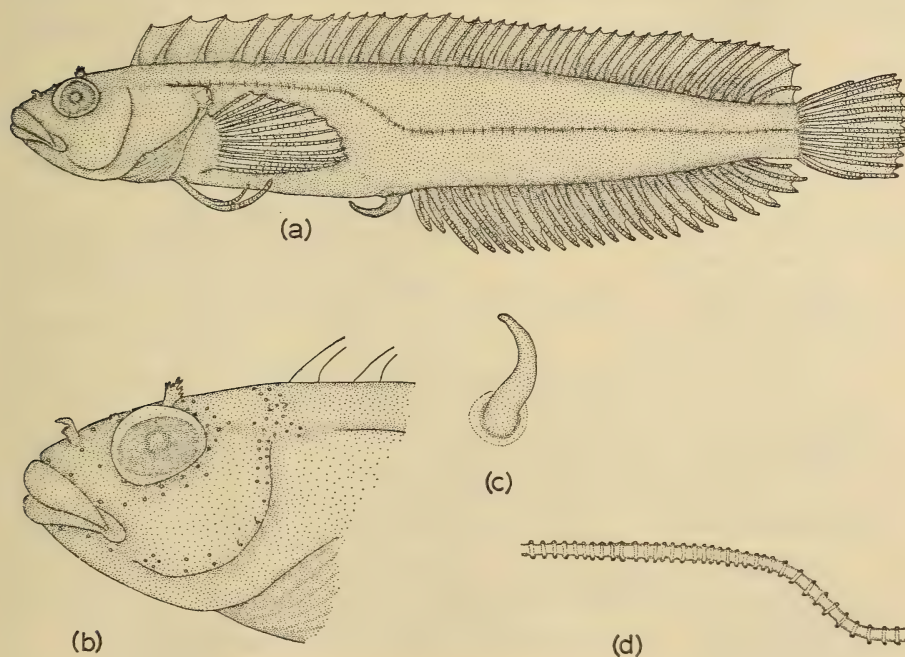


FIG. 9. *Clinus* (*Climacoporus*) *navalis*: (a) Lateral view, male, 55·5 mm, S.A.M. 18287, holotype; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

genus *Clinus*, particularly *Clinus dorsalis*, I believe that to set this species apart on account of the lateral line would obscure its relationships with the rest of the group. The intromittent organ, however, is very peculiar. In the few male specimens available it was very strongly erect; the finer structure may have been obscured to some extent. There is some resemblance to the erect organ of *C. brevicristatus*, which shows but little definition at the tip.

Distribution (fig. 4). The known range is Still Bay ($34^{\circ}23'S.$, $21^{\circ}24'E.$) to Port St. Johns ($31^{\circ}37'S.$, $29^{\circ}32'E.$). The first specimen described was found among barnacles on a ship's bottom at Simonstown, but the species does not normally occur in the region of the Cape Peninsula.

Subgenus *Clinus* Cuvier, 1817

Clinus Cuvier, 1817: 173 (type-species *Blennius acuminatus* Bloch & Schneider).

Clinitrachus Swainson, 1839: 75 (in part); (type-species *Blennius variabilis* Rafinesque).

Ophthalmolophus Gill, 1860: 104 (type-species *Clinus latipennis* Valenciennes).

Blenniominus Smith, 1945: 538 (type-species *Clinus taurus* Gilchrist & Thompson).

Caboclinus Smith, 1966: 73 (type-species *Clinus robustus* Gilchrist & Thompson).

Diagnosis. Body not elongate. Head naked. No barbels on chin or snout. More than one dorsal soft ray.

Thirteen species, occurring mainly among rocks in intertidal pools. These species are difficult to identify from a key, as they are extremely variable. Two keys are given, but species should always be compared with the description as well.

Key to the species of the subgenus *Clinus*

1. Anterior three dorsal spines, or at least the second and third dorsal spines, elevated, higher than fourth dorsal spine 2
Anterior three dorsal spines equal to or shorter than fourth dorsal spine 6
2. Dorsal soft rays three or less. Second spine highest; no notch in membrane between third and fourth dorsal spines *Clinus (Clinus) venustris*
Dorsal soft rays four or more; a notch of varying depth in membrane between third and fourth dorsal spines 3
3. Pectoral rays 15 or more *Clinus (Clinus) superciliosus*
Pectoral rays 14 or fewer 4
4. Crest high, triangular; dorsal fin originates over hind margin of eye *Clinus (Clinus) woodi*
Crest low, rectangular to rounded; dorsal fin originates over hind margin of preopercle 5
5. Lips with vertical corrugations; dorsal soft rays nine or more *Clinus (Clinus) robustus*
Lips smooth; dorsal soft rays seven or fewer *Clinus (Clinus) brevicristatus*
6. A notch of varying depth in membrane between third and fourth dorsal spines 7
No notch in membrane between third and fourth dorsal spines 8
7. Interorbital concave, strong bony ridges over eyes; occiput with deep transverse groove *Clinus (Clinus) taurus*
Interorbital flat, no ridges over eyes; no deep occipital groove *Clinus (Clinus) agilis*
8. Interorbital strongly concave, bony ridges over eye; occipital groove deep; dorsal soft rays six or fewer *Clinus (Clinus) cottoides*
Interorbital flat, or only slightly concave; occipital grooves if present shallow 9
9. Dorsal soft rays 8-9 *Clinus (Clinus) latipennis*
Dorsal soft rays seven or fewer 10
10. Dorsal soft rays 2-3 *Clinus (Clinus) venustris*
Dorsal soft rays 4-7 11

11. Dorsal spines 34-37.. .. . 12
 Dorsal spines 33 or fewer 13
12. Mucous pores on head open on papillae; snout bluntly rounded *Clinus (Clinus) helenae*
 Mucous pores on head open flush with surface; snout more or less wedge-shaped *Clinus (Clinus) berrisfordi*
13. First dorsal spine shorter than fourth spine; pectoral rays usually 12; intromittent organ of male broad and flattened towards tip *Clinus (Clinus) acuminatus*
 First dorsal spine equal to or very slightly longer than fourth; pectoral rays 13; intromittent organ of male slender, cylindrical *Clinus (Clinus) heterodon*

Alternative key to the species of the subgenus Clinus

No. of
soft dorsal
rays

- 2-3 1. Dorsal spines 39-41.. .. . *Clinus (Clinus) venustis*
 Dorsal spines 34-37.. .. . *Clinus (Clinus) agilis*
- 4 1. Interorbital concave *Clinus (C.) cottoides*
 Interorbital flat 2
2. First three dorsal spines higher than fourth, forming a crest 3
 First three dorsal spines lower than fourth, not forming a crest 4
3. Pectoral rays 15 or more *Clinus (C.) superciliosus*
 Pectoral rays 14 or fewer *Clinus (C.) brevicristatus*
4. A notch in membrane between third and fourth dorsal spines; dorsal spines 34-37 *Clinus (C.) agilis*
 No notch in membrane between third and fourth dorsal spines; dorsal spines 33 or fewer *Clinus (C.) acuminatus*
- 5 1. First three dorsal spines higher than fourth, forming a crest 2
 First three dorsal spines lower than or equal to fourth, not forming a crest 4
2. Pectoral rays 15 or more *Clinus (C.) superciliosus*
 Pectoral rays 14 or fewer 3
3. Crest high, triangular, originates over hind margin of eye *Clinus (C.) woodi*
 Crest low, originates over hind margin of preopercle *Clinus (C.) brevicristatus*
4. A notch in membrane between third and fourth dorsal spines *Clinus (C.) taurus*
 No notch in membrane between third and fourth dorsal spines 5
5. A large round black spot on the opercle *Clinus (C.) cottoides*
 No large black spot on opercle 6
6. First dorsal spine lower than fourth 7
 First dorsal spine equal to or a little longer than fourth *Clinus (C.) berrisfordi*
7. Dorsal spines 33 or fewer; pectoral rays 12 *Clinus (C.) acuminatus*
 Dorsal spines 34 or more; pectoral rays 13 *Clinus (C.) helenae*
- 6 1. First three dorsal spines high, forming a crest 2
 First three dorsal spines not forming a crest 3
2. Pectoral rays 15 or more *Clinus (C.) superciliosus*
 Pectoral rays 14 or fewer *Clinus (C.) brevicristatus*
3. A notch in membrane between third and fourth dorsal spines *Clinus (C.) taurus*
 No notch in membrane between third and fourth dorsal spines 4
4. A large round black spot on the opercle *Clinus (C.) cottoides*
 No large black spot on opercle 5
5. First dorsal spine lower than fourth 6
 First dorsal spine equal to or a little longer than fourth 7
6. Pectoral rays 12; dorsal spines 33 or fewer *Clinus (C.) acuminatus*
 Pectoral rays 13; dorsal spines 34 or more *Clinus (C.) helenae*
7. Pectoral rays 12 *Clinus (C.) berrisfordi*
 Pectoral rays 13 *Clinus (C.) heterodon*
- 7 1. First three dorsal spines high, forming a crest 2
 First three dorsal spines not forming a crest 3

No. of
soft dorsal
rays

7	2.	Pectoral rays 15 or more	<i>Clinus (C.) superciliosus</i>
		Pectoral rays 14 or fewer	<i>Clinus (C.) brevicristatus</i>
	3.	First dorsal spine lower than fourth; pectoral rays 12; intromittent organ of male broad and flattened toward tip	<i>Clinus (C.) acuminatus</i>
		First dorsal spine equal to or a little higher than fourth; pectoral rays 13; intromittent organ of male slender, cylindrical	<i>Clinus (C.) heterodon</i>
8	1.	First three dorsal spines high, forming a crest	<i>Clinus (C.) superciliosus</i>
		First three dorsal spines not forming a crest	<i>Clinus (C.) latipennis</i>
9	1.	Lips with vertical corrugations	<i>Clinus (C.) robustus</i>
		Lips smooth	2
	2.	First three dorsal spines high, forming a crest	<i>Clinus (C.) superciliosus</i>
		First three dorsal spines not forming a crest	<i>Clinus (C.) latipennis</i>
10	1.	Lips with vertical corrugations	<i>Clinus (C.) robustus</i>
		Lips smooth	<i>Clinus (C.) superciliosus</i>
11-14		.. .. .	<i>Clinus (C.) robustus</i>

Clinus (Clinus) acuminatus (Bloch & Schneider, 1801)

(Fig. 10)

Blennius acuminatus Bloch & Schneider, 1801: 169.

Clinus acuminatus: Cuvier, 1817: 175. Valenciennes in Cuvier & Valenciennes, 1836: 370. Swainson, 1839: 75. Gilchrist & Thompson, 1908: 124. Barnard, 1927: 859. Hubbs, 1952: 106. Smith, 1966: 73. Penrith 1967: 43, figs 1, 4(a).

Ophthalmolophus acuminatus: Smith, 1945: 542, 1949: 355, pl. 79 fig. 991.

Description. D. XXXI-XXXIII (XXXII-XXXIII) 5-7; A. II 20-24 (21-22); P. 12-13 (12); V. I 2-3; C. 13. Gill-rakers in outer series on first arch 1-2 + 4-6. Vertebrae 16 + 27-29. Dorsal fin low, even. Clusters of 2-3 cirri at tips of dorsal spines for about half length of dorsal fin. Pectoral fin rounded. Inner pelvic ray reduced or absent. Caudal peduncle short, length 20.5-33.5% head length, depth 20-35% head length. Caudal fin subtruncate.

Body slightly compressed, covered with small scales extending on to dorsal fin base; caudal and anal fin bases and head naked. Depth 4.5-6 in standard length. Head large, 3.2-4 in standard length, snout wedge-shaped, angle of profile acute. Eye 2.75-5 in head. Supraorbital tentacle prominent, with short, flattened stalk terminating in several short, simple branches. Cirrus on anterior nostril short, flattened, trilobed. Upper jaw 34.5-50% head length, increasing with size of fish. Lips moderate. Vomer toothed. Sensory pores of all head series single excepting last pore of preopercular series and one pore of suborbital series, which are double (fig. 10(b)).

Lateral line usually of 2-4 vertical pairs of pores in front above opercle, then of mainly single pores opening above and below the line to post-pectoral curve; after that of short separate horizontal tubes with pore at either end (fig. 10(d)). Intromittent organ of male large, flattened, and spade-shaped, with moderately long, thick basal portion, pair of small dorsal lips, and large,

broad pair of ventro-lateral lips ensheathing tip (fig. 10(c)).

Colouring. Light green with broad, well-defined dark brown cross-bars, or with black speckling in sparse large spots with mosaic-like pattern. Tips of all fins and of supraorbital tentacles reddish orange. Belly silvery white. Dark ocellate spot on shoulder, and two dark radiating bands from eye across cheek. Small juveniles white with well-defined black cross-bars. Pattern retained for several years after preservation.

Location of type material. Unknown.

Material examined. 182 specimens, 19–113.5 mm in standard length. 17 from Lüderitzbucht, S.A.M. 10544, S.A.M. 24206; 38 from McDougall's Bay, Port

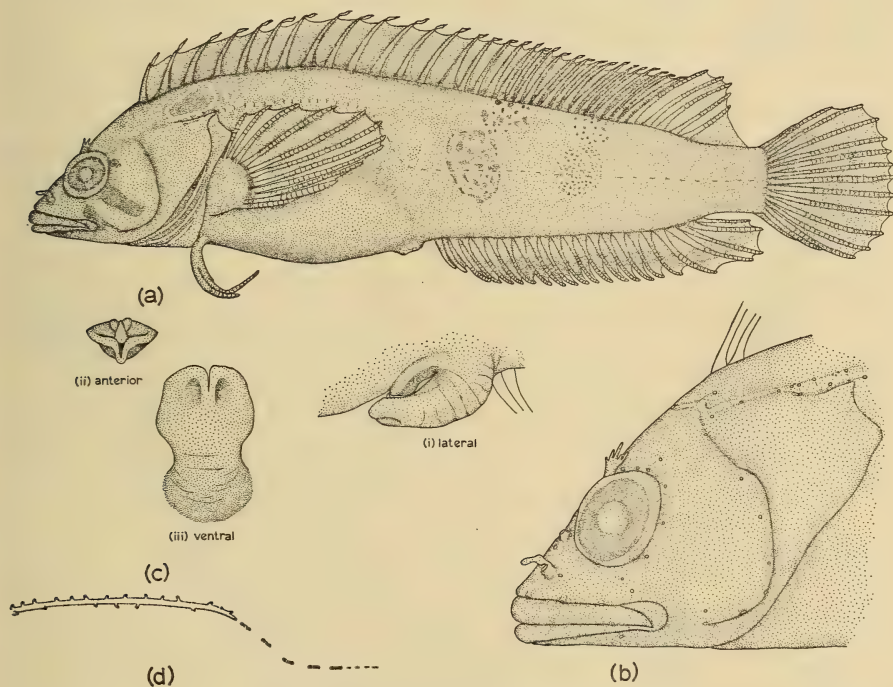


FIG. 10. *Clinus (Clinus) acuminatus*: (a) Lateral view, female, 73 mm, S.A.M. 24255; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Nolloth, S.A.M. 24220; 12 from Port Nolloth, 12/7/1960, R.U.C.; 15 from Lambert's Bay, S.A.M. 21477, S.A.M. 23922 and 17/1/1964, S.A.M. not catalogued; 18 from Lambert's Bay, R.U.C.; 2 from Lambert's Bay, University of Cape Town; 2 from Schaapen Island, Langebaan, S.A.M. 23925; 8 from Sea Point, S.A.M. 22840, S.A.M. 23211; 3 from Kommetjie, S.A.M. 10541; 3 from Froggy Pond, False Bay, S.A.M. 23924; 28 from St. James, False Bay, S.A.M. 12023 and 1962, S.A.M. not catalogued; 2 from St. James, False Bay, R.U.C.; 21 from False Bay, S.A.M. 10542; 2 from Cape Peninsula, University of Cape

Town; 4 from Onrust River Mouth, 6/11/1964, S.A.M. not catalogued; 2 from Die Dam, Bredasdorp District, S.A.M. 24508; 5, no locality, R.U.C.

Remarks. *Clinus acuminatus* is similar on the one hand to *Clinus agilis*, having a flat interorbital, and on the other hand to species such as *Clinus cottoides*, *Clinus heterodon*, *Clinus latipennis*, and *Clinus helenae*, which lack a notch in the membrane between the third and fourth dorsal spines. It is also very similar to *Clinus berrisfordi*. Small specimens are rather similar in appearance to *Clinus dorsalis*, and occupy the same type of habitat. Smith's (1931) suggestion that *Clinus agilis* may be found to be a subspecies of *Clinus acuminatus* is not supported by a comparison of the two species, which are not sufficiently alike in appearance to be confused even in the field. Furthermore, they occur over the same geographical range and often in the same pools.

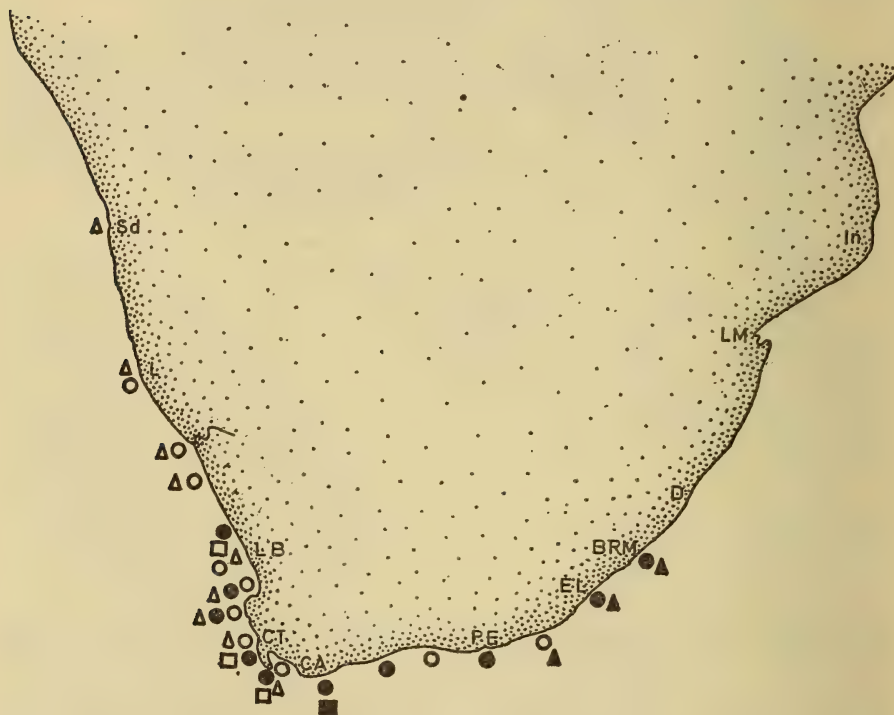


FIG. 11. Distribution of *C. agilis* (open circles), *C. berrisfordi* (closed squares), *C. brevicristatus* (open squares), *C. cottoides* (closed circles), *C. helenae* (closed triangles), *C. heterodon* (open triangles).

Distribution (fig. 4). The known range is Lüderitzbucht ($26^{\circ}28'S.$, $15^{\circ}10'E$) (South West Africa) to Cape Agulhas ($34^{\circ}50'S.$, $20^{\circ}00'E$). It is more common west of Cape Point. This species occurs in shallow, barren pools under stones and ledges at the top of the intertidal region of the shore.

Clinus (Clinus) agilis Smith, 1931

(Fig. 12)

Clinus agilis Smith, 1931: 154, pl. 16, 1966: 73.*Ophthalmolophus agilis*: Smith, 1945: 54, 1949: 355, pl. 77 fig. 988.*Ophthalmolophus anne* Smith, 1947b: 733, fig. 2, 1949: 355, pl. 77 fig. 989.*Clinus anne*: Smith, 1966: 73.

Description. D. XXXII-XXXVIII (XXXV-XXXVII) 2-4 (3); A. II 20-25 (22-23); P. 13-15; V. I 2-3; C. 13. Gillrakers in outer series on first arch 1-2 + 3-5. Vertebrae 16 (rarely 17) + 27-30. Dorsal fin low, first three spines not elevated to form crest, but notch in membrane between third and fourth dorsal spines, varying in depth, rarely absent (see table 3). Clusters of 3-4 cirri at tips of dorsal spines for about half length of fin. Pectoral fin rounded. Inner pelvic ray, if present, minute; usually absent. Caudal peduncle short, length 23-31 % head length, depth 25.5-29 % head length. Caudal fin subtruncate.

Body slightly compressed, covered with small scales not extending on to fin bases or head. Depth 4.5-5.25 in standard length. Head 3.5-4.5 in standard length, snout rounded. Eye 3-4.25 in head. Supraorbital tentacle prominent, with flat stalk dividing into several short simple branches at tip. Cirrus on anterior nostril long, narrow, pointed. Upper jaw 40-50 % head length. Lips fairly thick. Vomer toothed. Sensory pores of head single in nasal and interorbital series, mainly single in mandibular and preopercular series; pores in remaining series double or multiple (fig. 12(b)).

Lateral line of vertical pairs of pores and single pores opening above and below line in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 12(d)). Intromittent organ of male with long basal portion; tip completely ensheathed by 2 pairs of confluent lips. Pair of rounded fleshy lobes within fold, between which is minute tip (fig. 12(c)).

Colouring. Ground colour usually dark greyish or greenish, with about 7 distinct dark red and green cross-bars. Occasional specimens have pinkish or milky ground colour with darker pink cross-bars, or vermilion ground colour with dark brown cross-bars. Fins dark, irregularly barred; characteristic translucent area in membrane joining dorsal soft rays. Belly silvery white to greyish. Sprinkling of white spots over body sometimes. Head with irregular lacy patterns in body colours, or plain dark grey. Light-edged dark ocellate spot on shoulder usually. Juveniles white with well-defined red cross-bars. Pattern remains for several years after preservation.

Location of type material. Department of Ichthyology, Rhodes University, Grahamstown. One paratype in South African Museum.

Material examined. 672 specimens, 17-113 mm in standard length. 191 from Lüderitzbucht, S.A.M. 24205; 1 from Sinclair's Island, R.U.C.; 3 from Orange River Mouth, 5 fms, S.A.M. 23964; 246 from Port Nolloth, S.A.M. 24214; 1 from Hondeklip Bay, March 1965, S.A.M. not catalogued; 6 from Gert du

Toit Bay and 4 from Doring Bay, southern Namaqualand, S.A.M. 24232; 5 from Lambert's Bay, R.U.C. (syntypes of *anne*); 108 from Lambert's Bay, S.A.M. 23919; 1 from Lambert's Bay, R.U.C.; 13 from Steenberg's Cove, St. Helena Bay, 1962, S.A.M. not catalogued; 3 from Saldanha Bay, S.A.M. 22072, S.A.M. 23921; 5 from Langebaan, S.A.M. 21475, S.A.M. 21479; 38 from Sea Point, S.A.M. 23212, S.A.M. 23920, and 17/2/1965, S.A.M. not catalogued; 6 from Froggy Pond, False Bay, S.A.M. 23906; 2 from Dalebrook, False Bay, 19/2/1965, S.A.M. not catalogued; 1 from Knysna, S.A.M. 18278 (paratype); 38 from Knysna, S.A.M. 24233.

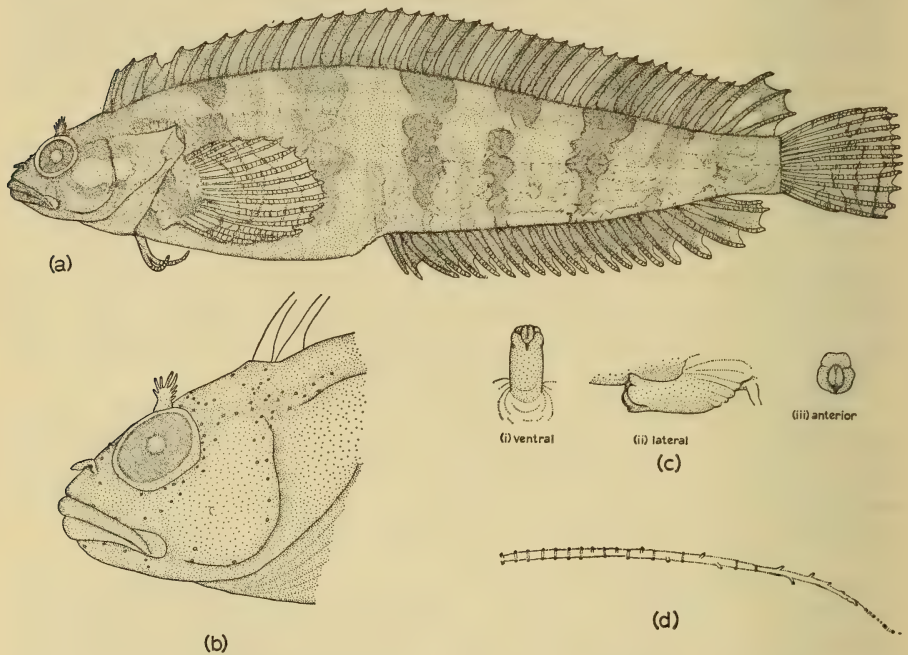


FIG. 12. *Clinus (Clinus) agilis*: (a) Lateral view, female, 113 mm, Hondeklip Bay, S.A.M.; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Remarks. It has been believed for some time at the South African Museum that this species and *Ophthalmolophus anne* Smith, 1947, are probably conspecific. In attempting to identify large samples from the west coast, one might arrive at either species in Smith's (1949) key, or at both species for different specimens of the same sample. Smith (1931) created *agilis* for seven specimens taken from Knysna estuary, ranging in size from 55–65 mm. In 1947 he created *anne* for five specimens, 24–50 mm, from the west coast, mainly Lambert's Bay. He differentiated *anne* from *agilis* on the following points: (1) number of dorsal spines (34–35 for *agilis*, 36–37 for *anne*); (2) eye size (3–4 in head in *agilis*,

4.2-4.5 in head in *anne*); (3) snout length (greater in *anne*, no figures given); (4) pectoral length (greater in *anne*, no figures given); (5) pelvic length (less in *anne*, no figures given). Since so few specimens were examined, and the size range of the samples did not overlap, the four points relating to body proportions may probably be ignored. In the Clinidae body proportions have been found to vary considerably with size, so that comparable size ranges are essential for the comparison of body proportions of different species; furthermore, the ranges found for body proportions tend to be very wide in the Clinidae, so that other features are usually more important for delimiting species. In any case, the orbit diameter of 19 specimens of *Clinus agilis*, all from the west coast and therefore falling in Smith's species *anne*, was measured and was found to be 2.6-4.25 in head (size range of specimens 31-93 mm in standard length), very close to the range found by Smith (1931) for his Knysna specimens. 15 specimens from Knysna, ranging from 31-59 mm in standard length, showed an orbit diameter range 2.5-3.5 (see table 4). As far as the dorsal spine count is

TABLE 4. Comparison of orbit diameter of *Clinus agilis* from south-east and south-west coasts of the Cape.

East Coast (<i>agilis</i> Smith)		West Coast (<i>anne</i> Smith)	
Std. length	Eye in head	Std. length	Eye in head
(mm)		(mm)	
31	3.3	31	3.3
31	2.7	31	2.8
32	3.3	31	3.3
33	3.3	33	3.3
35	3.0	35	2.9
37	3.0	37	2.7
39	2.5	38	2.6
39	3.0	39	3.1
42	2.9	42	3.0
48	2.9	47	3.0
49	3.4	49.5	3.3
51	3.5	51	3.4
52	3.5	53	3.5
55	2.9	55	3.1
59	3.3	60	3.4
		67	3.5
		70	3.6
		82	4.25
		93	3.8

concerned, samples from the west coast showed a range of 33-38 dorsal spines, which covers the range of 34-35 of *agilis*. Furthermore, samples from different areas along the coast showed variation in the average number of dorsal spines for each population. This is shown in a histogram (fig. 13). The variation from one population to another is an interesting indication of the lack of genetic exchange between populations along the coast, a lack not surprising in view of the sedentary mode of life and the methods of reproduction of these small fishes. That such variation between localities occurs makes one hesitate to recognize even a racial difference between the east and west coast forms. The

identical intromittent organ of east and west coast specimens is the strongest argument in favour of joining these species, since the shape of the intromittent organ is strongly species-specific in the genus *Clinus*.

Smith (1947*b*) stated that if the seven Knysna specimens and the five west coast (Lambert's Bay) specimens had not been so widely separated geographically he would have placed them in the same species. A study of clinid distribution in South Africa has shown that there are few species from the west coast of South Africa that do not occur at least as far east as Port Elizabeth, so that the occurrence of a species at both Lambert's Bay and Knysna is not unexpected,

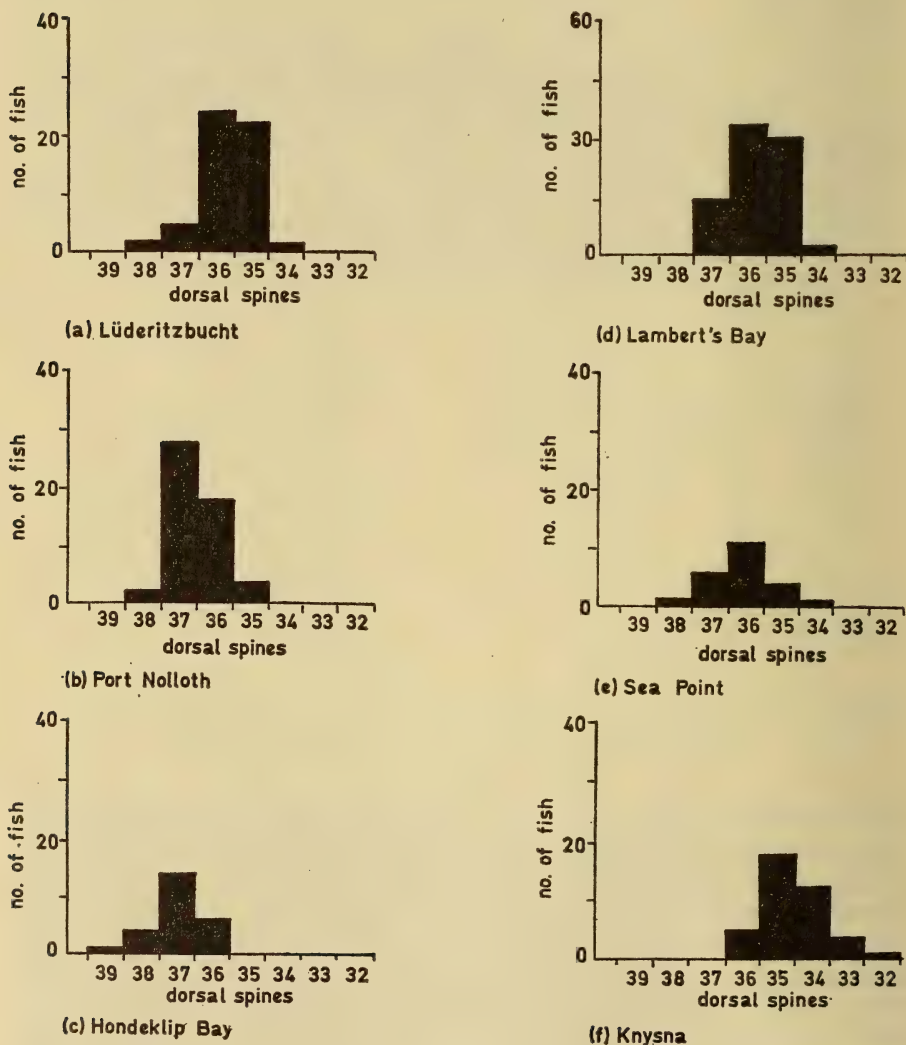


FIG. 13. Histogram showing dorsal spine count variation in different populations of *Clinus agilis*.

particularly when the species has been recorded from False Bay on several occasions as well.

It is proposed therefore that *Ophthalmolophus anne* Smith, 1947, should become a synonym of *Clinus agilis* Smith, 1931, since the two species are indistinguishable. *Clinus agilis* is common on the west coast of South Africa but becomes rare east of Cape Point.

Barnard (1948) suggested that *Clinus agilis* might be the young of *Clinus taurus* Gilchrist & Thompson, but the two species are easily distinguishable in all stages by the shape of the interorbital, which is strongly concave in *Clinus taurus* and flat in *Clinus agilis*, and by the number of dorsal soft rays (2-4 in *Clinus agilis* and 5-6 in *Clinus taurus*).

Clinus agilis is in some ways intermediate between forms with a low, even dorsal fin and no notch in the dorsal fin membrane between the third and fourth spines, such as *Clinus acuminatus*, and forms with a low dorsal crest and a notch in the dorsal fin membrane such as *Clinus brevicristatus*. There is a marked similarity in appearance between *Clinus agilis* and *Clinus brevicristatus* both in body form and colour pattern, but in the latter the first three dorsal spines are elevated, forming a crest, and there are more dorsal soft rays.

Distribution (fig. 11). The known range of this species is Lüderitzbucht (26°28'S., 15°10'E) (South West Africa) to Port Alfred (33°36'S., 26°54'E), common on the west coast in pools at all levels of the shore and also taken infratidally, but on the whole rare on the east coast, although a fairly large number of specimens was taken in Knysna lagoon. The biota of the Knysna estuary has been discussed by Day *et al.* (1952) and Day (1967). It is an exceptionally rich faunal area, and has also received a great deal more attention than any other area on the south coast of South Africa. A similar case of apparently discontinuous distribution involving a lagoon is observed in *Blennioclinus brachycephalus* on the west coast (Penrith, 1965*b*), without racial differentiation of the separated populations.

Clinus (*Clinus*) *berrisfordi* Penrith, 1967
(Fig. 14)

Clinus berrisfordi Penrith, 1967: 48, figs 3, 4(c).

Description. D. XXXIII-XXXVI (XXXIV-XXXV) 5-6; A. II 23-25 (23-24); P. 11-12 (12); V. I 3; C. 13. Gill-rakers in outer series on first arch 3-4 + 6-7. Vertebrae 16 (rarely 17) + 28-31. First three dorsal spines not elevated to form crest, but equal to or little longer than fourth dorsal spine. No notch in membrane between third and fourth dorsal spines. Dorsal spines with clusters of three fine cirri at tips for about half length of fin. Pectoral fin rounded. Inner pelvic ray minute but present in all specimens examined. Caudal peduncle short, length 20-35% head length, depth 20-35% head length. Caudal fin subtruncate.

Body slightly compressed, covered with small scales extending on to dorsal and caudal fin bases but not anal fin base or head. Depth 4.5-5 in standard

length. Head 3.4-4 in standard length, snout wedge-shaped, profile acute. Eye 3-4.2 in head. Supraorbital tentacle prominent, with flattened stalk ending in several long slender filaments. Cirrus on anterior nostril with narrow stalk and flattened, bilobed tip. Upper jaw 36.4-50% of head length. Lips moderate. Vomer toothed. Sensory pores of nasal, interorbital and mandibular series single with exception of double first pore in mandibular series; pores of remaining series double or multiple (fig. 14(b)).

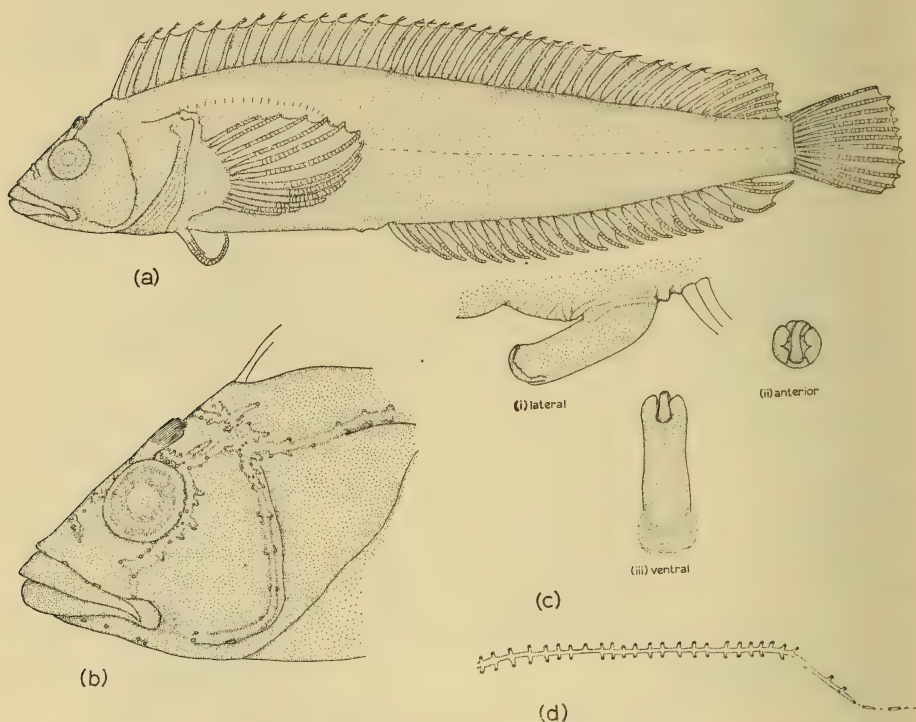


FIG. 14. *Clinus (Clinus) berrisfordi*: (a) Lateral view, female, 95 mm, S.A.M. 24221, holotype; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Lateral line of usually vertical pairs of pores in front to post-pectoral curve, few single pores opening above or below line, then of short separate horizontal tubes with pore at either end (fig. 14(d)). Intromittent organ of male with a long basal portion and a slender upturned tip ensheathed by a pair of bilobed ventro-lateral lips and a small pair of rounded dorsal lips (fig. 14(c)).

Colouring. Reddish orange with about seven faint broad darker cross-bars. Two dark radiating lines from eye across cheek. Dark ocellate spot on shoulder. Fins reddish orange, faintly mottled and barred. Plain yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Material examined. 16 specimens, 37.5-106 mm in standard length. 16 from Onrust River Mouth, S.A.M. 24601 (holotype), S.A.M. 24221 (paratypes).

Remarks. This species is similar in appearance to *Clinus acuminatus* and *Clinus heterodon* but differs from the former in the dorsal and anal fin counts, the form of the intromittent organ, the height of the first dorsal spine, the form of the supraorbital tentacle, the anterior part of the lateral line, and the habitat, occurring at a much lower level on the shore. It differs from the latter in the dorsal, anal, and pectoral fin counts, the intromittent organ (although of all the species of *Clinus*, *Clinus berrisfordi* and *Clinus heterodon* have the most similar form of intromittent organ), the anterior part of the lateral line, the clusters of cirri on the dorsal spines, and in having a narrower interorbital.

Distribution (fig. 11). So far taken only at Onrust River Mouth ($34^{\circ}25'S$, $19^{\circ}10'E$). The 16 specimens were taken from a weedy pool at the bottom of the intertidal region.

Clinus (*Clinus*) *brevicristatus* Gilchrist & Thompson, 1908

(Fig. 15)

Clinus brevicristatus Gilchrist & Thompson, 1908: 118. Barnard, 1927: 856.

Petraites brevicristatus: Smith, 1945: 540, 1949: 353, pl. 78 fig. 985.

Description. D. XXXIII-XXXVI (XXXV-XXXVI) 4-7 (5); A. II 21-24; P. 12-14 (12-13); V. I 3; C. 13. Gill-rakers in outer series on first arch 1-2 + 3-4. Vertebrae 17-18 + 27-31. First three dorsal spines elevated to form low crest, fourth dorsal spine 70% to over 90% first dorsal spine. Notch of varying depth in membrane between third and fourth dorsal spines (see table 3). Clusters of 4-6 cirri at tips of all dorsal spines. Pectoral fin rounded. Inner pelvic ray minute. Caudal peduncle short, length 21-34.5% head length, depth 21-28% head length. Caudal fin subtruncate.

Body slightly compressed, covered with small scales extending on to dorsal fin base but not caudal or anal fin bases or head. Depth 4.5-5 in standard length. Head 3.75-4.75 in standard length, snout bluntly rounded. Eye 2.75-3.25 in head. Supraorbital tentacle prominent, with short subcylindrical stalk and round, flattened tip ending in several simple branches. Cirrus on anterior nostril prominent, elongate, flat, and narrow, with slightly indented margin. Upper jaw 40-48.5% head length. Lips fairly thin. Vomer toothed. Sensory pores of head single in nasal and interorbital series and in mandibular series with exception of first, double pore; multiple as well as double pores in supra-orbital, postorbital, occipital and preopercular series (fig. 15(b)).

Lateral line of usually about 25 vertical pairs of pores in front (few may be single opening above or below line), to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 15(d)). Intromittent organ of male with fairly long basal portion and single pair of dorso-lateral lips ensheathing base of tip, which is slightly swollen, narrowing terminally (fig. 15(c)).

Colouring. Ground colour usually light grey, with about seven vermilion cross-bars, having shorter brown bars between them. The cross-bars may, however,

be various shades of green, brown, or deep red. The cross-bars extend on to dorsal and anal fins, but membrane joining dorsal soft rays has irregular translucent patches. Caudal and pectoral fins finely barred with dark brown. A 3-shaped dark mark at base of pectoral fin, and a dark stripe from edge of branchiostegal membrane to central edge of pectoral fin base. Operculum with irregular dark mark; two irregular dark bands radiate from eye across cheek. Pelvic fins barred with brown. Belly silvery white to greyish. Head grey or pinkish. Pattern retained for several years after preservation.

Location of type material. South African Museum, Cape Town.

Material examined. 36 specimens, 37.5–106 mm in standard length. 2 from Lambert's Bay, R.U.C.; 1 from Simon's Bay, False Bay, S.A.M. 24243; 1 from Kalk Bay, False Bay, S.A.M. 9988 (holotype); 5 from Dalebrook, False Bay, S.A.M. 23870 and 18/12/1964, S.A.M. not catalogued; 1 from St. James, False Bay, 16/5/1965, S.A.M. not catalogued; 26 from Strandfontein, False Bay, S.A.M. 23871, S.A.M. 23872, S.A.M. 23954, S.A.M. 23971, S.A.M. 23976, S.A.M. 24242.

Remarks. *Clinus brevicristatus* is very similar to the species with a low dorsal fin, such as *Clinus cottoides*, *Clinus acuminatus*, *Clinus venustis*, and particularly *Clinus agilis*. The species was described from a single female specimen from Kalk Bay,

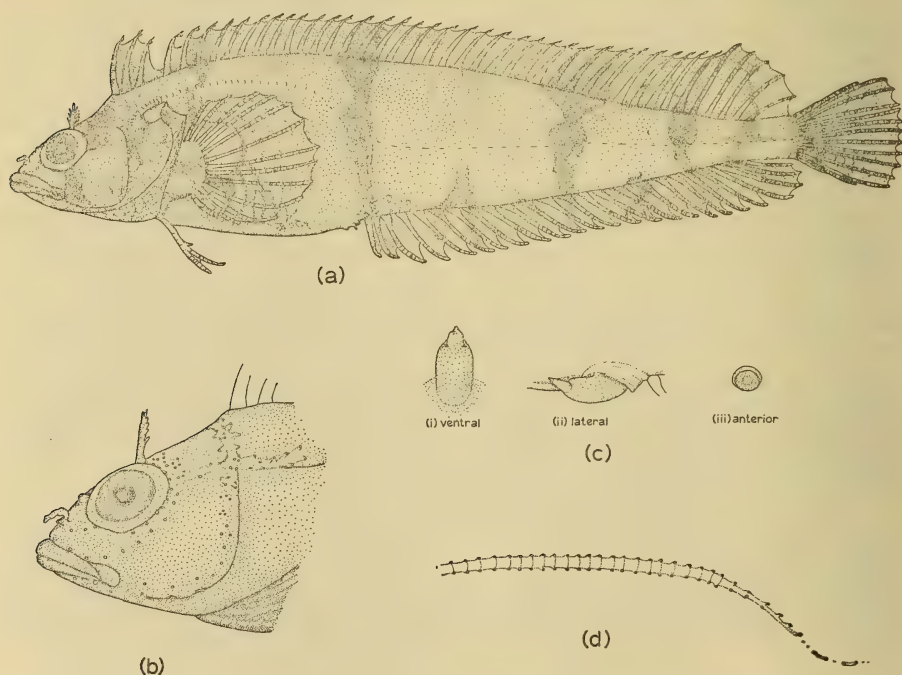


FIG. 15. *Clinus* (*Clinus*) *brevicristatus*: (a) Lateral view, female, 70 mm, S.A.M. 23870; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

in False Bay. I have collected additional specimens of both sexes from weedy areas at Strandfontein and Dalebrook in False Bay. The new material covers a fairly wide size range. This species is no more similar to *Clinus woodi*, with which it was placed in the genus *Petraites* by Smith (1945), than it is to *Clinus venustris* or *Clinus agilis*; in fact, it resembles the latter two species far more closely. The development of the crest is poor in both male and female specimens of *C. brevicristatus*, unlike that in *Clinus woodi*, in which the crest is high and triangular in both sexes, and almost entirely separate from the rest of the fin. In *Clinus brevicristatus* the crest is low and rounded, and resembles the crest of *Clinus agilis* (with a notch in the membrane between the third and fourth dorsal spines and the first three dorsal spines not elevated) more closely than it does the crest of *Clinus woodi*. *Clinus brevicristatus* does not appear to reach a large size. This species is unusual in the genus *Clinus* in that it lives almost exclusively in weed-beds. The peculiar intromittent organ of *C. navalis* is nearest to that of *C. brevicristatus*, which shows little definition of the thin dorso-lateral lips when fully erect.

Distribution (fig. 11). The known range is from Lambert's Bay ($32^{\circ}04'S.$, $18^{\circ}20'E$) to False Bay ($\pm 34^{\circ}10'S.$, $18^{\circ}50'E$). The species is not common. Smith (1937) gave the range as False Bay to Great Fish Point, but the latter limit was presumably an error, as it was not repeated in Smith's 1945 and 1949 works. Taken at low tide in False Bay from dense beds of the green alga *Caulerpa filiformis*, intertidal. —

Clinus (*Clinus*) *cottoides* Valenciennes in Cuvier & Valenciennes, 1836
(Fig. 16)

Clinus cottoides Valenciennes in Cuvier & Valenciennes, 1836: 367. Swainson, 1839: 276. Gilchrist & Thompson, 1908: 125. Barnard, 1927: 858.

Blenniomimus cottoides: Smith, 1945: 539, 1949: 353, pl. 78 fig. 983.

Description. D. XXXI-XXXVI (XXXIII-XXXIV) 4-6 (5-6); A. II 21-25; P. 12-14 (12-13); V. I 2-3; C. 13. Gill-rakers in outer series on first arch 2 + 5-6. Vertebrae 15 + 29-31. Dorsal fin low, even, anterior spines shortest; no notch in membrane between third and fourth dorsal spines. Pectoral fin rounded. Inner (third) pelvic ray minute or absent. Caudal peduncle short, length 30.5-34.5% head length, depth 21-26% head length. Caudal fin subtruncate.

Body slightly compressed, tapering markedly towards tail, covered with small embedded scales extending on to dorsal and caudal fin bases but not anal fin base or head. Depth 4.5-5.5 in standard length. Head very large, heavy, 3.25-4.25 in standard length. Snout bluntly rounded. Head becomes heavier in relation to body with age. Eye very large, 2.25-3.5 in head. Interorbital concave, bony ridge above each eye. Deep groove across occiput. Supraorbital tentacle prominent, on bony ridge, with flattened stalk and numerous long filamentous cirri terminally. Cirrus on anterior nostril short, flattened, with

about four short, simple branches terminally. Mouth large, increasing with size of fish, upper jaw 42–60% head length. Lips thin. Vomer toothed. Sensory pores of head single in nasal and interorbital series and on mandible except for first, double pore; mainly double in other series, and some multiple in occipital region (fig. 16(b)). Some pores in supraorbital and occipital regions open on minute papillae.

Lateral line usually of about 18–20 vertical pairs of pores, interspersed with or followed by few single pores opening above or below line, in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 16(d)). Intromittent organ of male with fairly long basal portion and single pair of slightly papillose dorso-lateral lips below which tip, which is slightly swollen at base with narrow termination, protrudes (fig. 16(c)).

Colouring. Ground colour slaty grey or dull greenish with irregular mottling, often in lacy pattern with vague crossbars extending on to dorsal and anal fins, chiefly dark grey, dark red, and whitish. Fins dusky, faintly mottled and barred. Three small dark lines on pectoral base. Prominent round black spot on opercle. Dark mark behind centre of eye, below which two narrow dark lines radiate from eye across cheek. Head and lips dusky to slate-grey; terminal filaments of supraorbital tentacles white. Belly white to greyish. Juveniles milky with fine lacy dark markings particularly in upper half of body; opercular spot well defined at all stages. Pattern retained for years after preservation.

Location of type material. Muséum National d'Histoire Naturelle, Paris.

Material examined. 951 specimens, 18–120 mm in standard length. 1 specimen, 63 mm in standard length, Cape, Paris Mus. Cat. No. A2078 (lectotype); 26 from Doring Bay, southern Namaqualand, S.A.M. 24229; 4 from southern Namaqualand, R.U.C.; 101 from Lambert's Bay, S.A.M. 23940; 12 from Lambert's Bay, R.U.C.; 3 from Saldanha Bay, S.A.M. 17914; 1 from Langebaan, S.A.M. 21880; 6 from Mouille Point, Cape Peninsula, 5/5/1965, S.A.M. not catalogued; 42 from Sea Point, S.A.M. 23941, S.A.M. 23942 and 17/2/1965, S.A.M. not catalogued; 1 from Hout Bay, S.A.M. 12013; 2 from Miller's Point, False Bay, S.A.M. 22906, S.A.M. 23937; 164 from Froggy Pond and Miller's Point, False Bay, S.A.M. 23939; 113 from Dalebrook, False Bay, 19/2/1965, 3/3/1965 and 18/4/1965 S.A.M. not catalogued; 25 from St. James, False Bay, S.A.M. 10540; 80 from Strandfontein, False Bay, S.A.M. 23978 and 12/1/1964 and 13/8/1964, S.A.M. not catalogued; 33 from Onrust River Mouth, S.A.M. 23938, S.A.M. 24230; 2 from Hermanus, S.A.M. 18095; 4 from Die Dam, Bredasdorp district, S.A.M. 24510; 59 from Still Bay, S.A.M. 24666; 35 from Mossel Bay, S.A.M. 23947; 4 from Knysna, S.A.M. 24230; 53 from Plettenberg Bay, S.A.M. 23946; 72 from Port Elizabeth, S.A.M. 23945, S.A.M. 23985; 1 from Kidd's Beach, East London, S.A.M. 20564; 14 from Igoda Mouth, East London, S.A.M. 25060; 104 from East London, S.A.M. 23943, S.A.M. 23944, S.A.M. 24228, and S.A.M. 20562; 2 from Gonubie River Mouth, East London, S.A.M. 25061; 2 from Kei Mouth,

S.A.M. 20563; 1 juvenile from Mozambique Island, R.U.C.

Lectotype of Clinus cottoides

I have examined three of the four syntypes of *Clinus cottoides*. Of these three syntypes, one small specimen is identifiable as the species regarded as *Clinus cottoides* in South Africa since the time of Gilchrist & Thompson (1908). The two larger syntypes are examples of a species known as *Clinus taurus* Gilchrist & Thompson. Dr. M. L. Bauchot kindly examined the remaining, dried syntype in the Paris Museum and concluded that it too represented *Clinus taurus*.

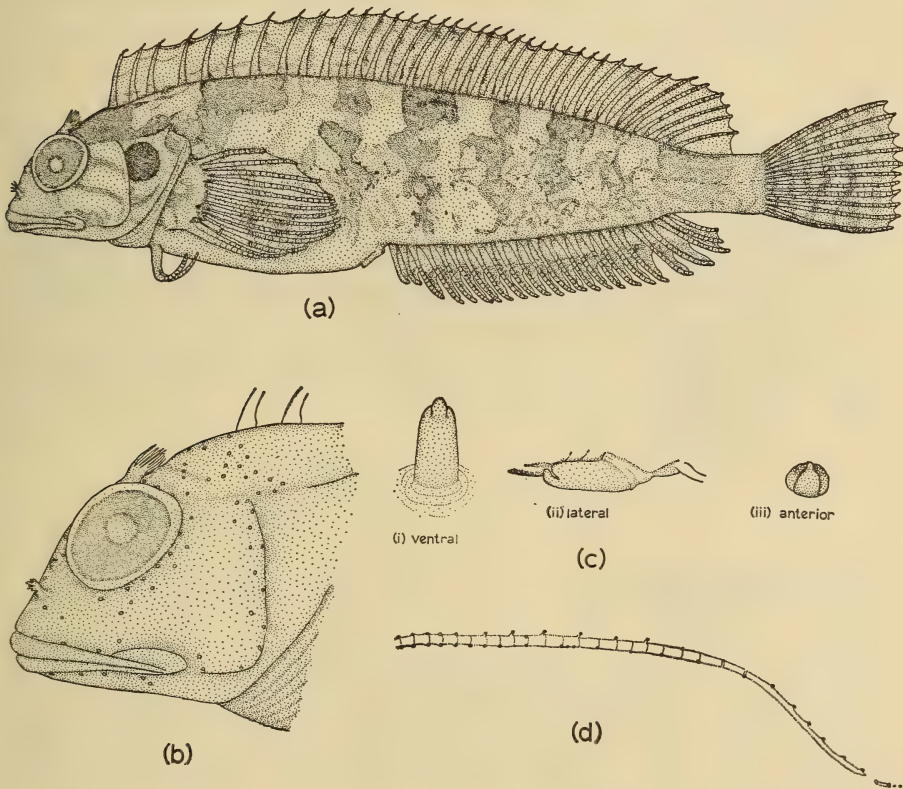


FIG. 16. *Clinus (Clinus) cottoides*: (a) Lateral view, female, 85 mm, S.A.M. 23945; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Although Valenciennes (1836 in Cuvier & Valenciennes) almost certainly based his description of *C. cottoides* on the larger specimens, the description applies more or less to both species; and the species was not figured. In order not to complicate the nomenclature of the two species, I here designate the small specimen, 63 mm, Paris Museum Catalogue No. A2078, of the four syntypes of *Clinus cottoides* the lectotype.

Remarks. Smith (1945) considered the concave interorbital of *Clinus cottoides* and of *Clinus taurus* to be of generic significance. However, *Clinus latipennis*, large specimens of *Clinus heterodon*, and to a slight degree *Clinus helenae*, also have a concave interorbital with low bony ridges over the eyes. Instead of a clear-cut division between species with and without a ridge over the eyes, there is a series, from *Clinus heterodon*, in which the supraorbital ridges develop only in large specimens, to *Clinus taurus*, in which the ridges are very heavy at all stages. These species all appear to be closely related to each other and to species lacking the ridge, such as *Clinus acuminatus* and *Clinus berrisfordi*.

Specimens of *Clinus cottoides* from East London were compared with specimens from Lambert's Bay, and no east-west clinal or individual population differences were found in the fin counts of this species. *Clinus cottoides* does, however, attain a considerably greater size on the west coast than it does east of Cape Point.

Distribution (fig. 11). The known range is from southern Namaqualand ($\pm 31^{\circ}40'S.$, $18^{\circ}15'E$) (Olifants River Mouth) to the Kei River ($32^{\circ}41'S.$, $28^{\circ}23'E$). It is one of the most abundant species from Lambert's Bay to the Kei River, particularly from False Bay eastwards. A single tiny juvenile from Mozambique Island was seen in the Rhodes University Ichthyology Department, but this seems to be well outside the normal range for this species, which has not been recorded otherwise much north of the Kei River. *Clinus cottoides* was recorded by Kner (1865-67) from Java, but De Beaufort & Chapman (1955) stated that this record is certainly erroneous; its occurrence outside South African waters is most improbable.

Clinus (Clinus) helenae (Smith, 1945)

(Fig. 17)

Ophthalmolophus helenae Smith, 1945: 542, fig. 3; 1949: 355, pl. 79 fig. 992.

Clinus helenae: Smith, 1966: 73.

Description. D. XXXIV-XXXVII 5-6; A II 24-25; P. 13; V. I 3; C. 13. Vertebrae 16 + 30. Dorsal fin low, even; no notch in membrane between third and fourth dorsal spines. No clusters of cirri at tips of dorsal spines. Pectoral fin rounded. Inner pelvic ray minute. Caudal peduncle short, length, 30-35.5% head length, depth 20-24% head length, noticeably longer than deep. Caudal fin subtruncate.

Body slightly compressed, covered with small embedded scales not extending on to dorsal, anal, or caudal fin bases or head. Depth 4.5-5 in standard length. Head 3.75-4.75 in standard length, snout bluntly rounded. Interorbital slightly concave, low bony ridges over eyes; occipital grooves moderately deep. Eye 3-5 in head. Supraorbital tentacle prominent, with flattened stalk and terminal fringe of long fine filamentous cirri. Cirrus on anterior nostril small, simple, flaplike. Upper jaw 39.5-52.5% head length. Lips moderately thick. Vomer toothed. Sensory pores of head single in nasal, interorbital, and

mandibular series except for first double mandibular pore; double or multiple in other series (fig. 17(b)). Many pores open on raised papillae, giving head a rough appearance.

Lateral line of vertical pairs of pores in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 17(d)). Intromittent organ of male with moderately long basal portion; small pair of circular dorsal lips and large pair of ventro-lateral lips with finely serrated ventral margins ensheathing tip. Small pair of lateral lobes on basal portion (fig. 17(c)).

Colouring. A single fresh specimen from Kei Mouth was light grey, with darker mottling in the form of irregular cross-bars; body and head speckled with white. Smith (1945) described the colouring of his specimens as 'light brown, with seven darker broken crossbands. Darker spots and speckles on head and body.'

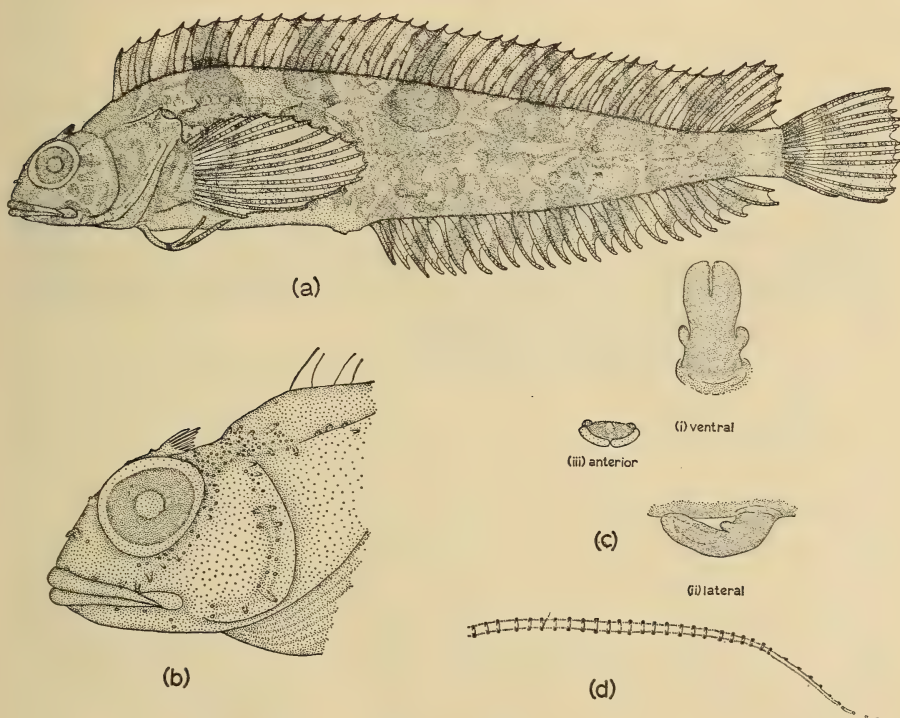


FIG. 17. *Clinus* (*Clinus*) *helenae*: (a) Lateral view, female, 71 mm, S.A.M. 25065; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

The fins are finely spotted and barred. Pattern retained for years after preservation.

Location of type material. Department of Ichthyology, Rhodes University, Grahamstown.

Material examined. 8 specimens, 67.5–78.5 mm in standard length. 4 from

Boknes Point, R.U.C. (syntypes); 3 from Cape Morgan, R.U.C. (syntypes); 1 from Kei mouth, S.A.M. 25065.

Remarks. *Clinus helenae* resembles *Clinus cottoides*, *Clinus taurus* and particularly *Clinus latipennis* in the form of the head, although the concave interorbital is least marked in *Clinus helenae*. It is also similar to *Clinus heterodon* (in which the interorbital becomes concave only in large specimens), *Clinus berrisfordi* and *Clinus acuminatus*. The intromittent organ is similar to that of *Clinus latipennis*, the only other species which has a pair of subsidiary lobes on the basal portion.

Distribution (fig. 11). The known range is Port Alfred ($33^{\circ}36'S.$, $26^{\circ}54'E$) to the Bashee River ($31^{\circ}55'S.$, $28^{\circ}27'E$); rare.

Clinus (Clinus) heterodon Valenciennes in Cuvier & Valenciennes, 1836
(Fig. 18)

Clinus heterodon Valenciennes in Cuvier & Valenciennes, 1836: 394.

Clinus obtusifrons Penrith, 1967: 46, figs 2, 4(b).

Description. D. XXX-XXXII (XXX-XXXI) 6-7; A. II 20-22 (20-21); P. 13; V. I 2-3; C. 13. Gill-rakers in outer series on first arch 1-2 + 5-6. Vertebrae 16 + 27-30. First three dorsal spines not forming crest, but equal to or a little longer than fourth spine, second spine longest. No notch in membrane between third and fourth dorsal spines. No clusters of cirri at tips of dorsal spines. Pectoral fin rounded. Inner (third) pelvic ray minute or absent. Caudal peduncle short, length 20-35% head length, depth 25-37.5% head length. Caudal fin subtruncate.

Body slightly compressed, covered with small embedded scales extending on to dorsal and caudal fin bases; anal fin base and head naked. Depth 4-5 in standard length. Head heavy, 3.2-4.5 in standard length. Interorbital concave with low supraorbital ridges in large specimens. Snout bluntly rounded, angle of profile obtuse. Eye 3-4.5 in head. Supraorbital tentacle prominent, with flattened stalk, terminating in several short, simple branches. Cirrus on anterior nostril flattened, expanded, and roughly triangular at tip. Upper jaw 36.4-50% head length, increasing with size of fish. Lips moderate. Vomer toothed. Sensory pores of head single in nasal and interorbital series, mainly single in mandibular, suborbital, and preopercular series. Mainly double and multiple in remaining series (fig. 18(b)). A few pores in occipital region open on raised papillae.

Lateral line of single pores, opening above or below line, in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 18(d)). Intromittent organ of male with moderately long basal portion and slender, upwardly hooked tip between pair of lateral lips and small rounded pair of dorsal lips (fig. 18(c)).

Colouring. Dusky or slaty with darker grey, irregular, lacy cross-bars, speckled with white and sometimes dark blue when fresh. Tips of anal and pelvic rays red. Prominent blue-edged spot on shoulder. Two dark radiating bars across

cheek. Tips of dorsal fin and orbital tentacles white. Pattern retained for years after preservation.

Location of type material. Muséum National d'Histoire Naturelle, Paris.

Material examined. 113 specimens, 20–116 mm in standard length. 1 specimen, Cape, Paris Museum Cat. No. A 1885 (holotype); 1 from Milestone 26, north of Swakopmund, S.A.M. 24201; 2 from Lüderitzbucht, S.A.M. 24211; 1 from Sinclair's Island, August 1947, R.U.C.; 12 from Port Nolloth, S.A.M. 24216, 5 from Port Nolloth, 27/4/1950 R.U.C.; 4 from Hondeklip Bay, S.A.M. 24671, S.A.M. 24670 (holotype and paratypes of *obtusifrons*); 1 from Hondeklip Bay, 28/4/1960, R.U.C.; 3 from Gert du Toit Bay, southern Namaqualand, S.A.M. 24253; 1 from Doring Bay, southern Namaqualand, 26/4/1960, R.U.C.; 58 from Lambert's Bay, R.U.C.; 3 from Ysterfontein, 20/2/1948, R.U.C.; 7 from Sea Point, S.A.M. 25068; 6 from False Bay, March 1947, R.U.C.; 8, no locality, R.U.C.

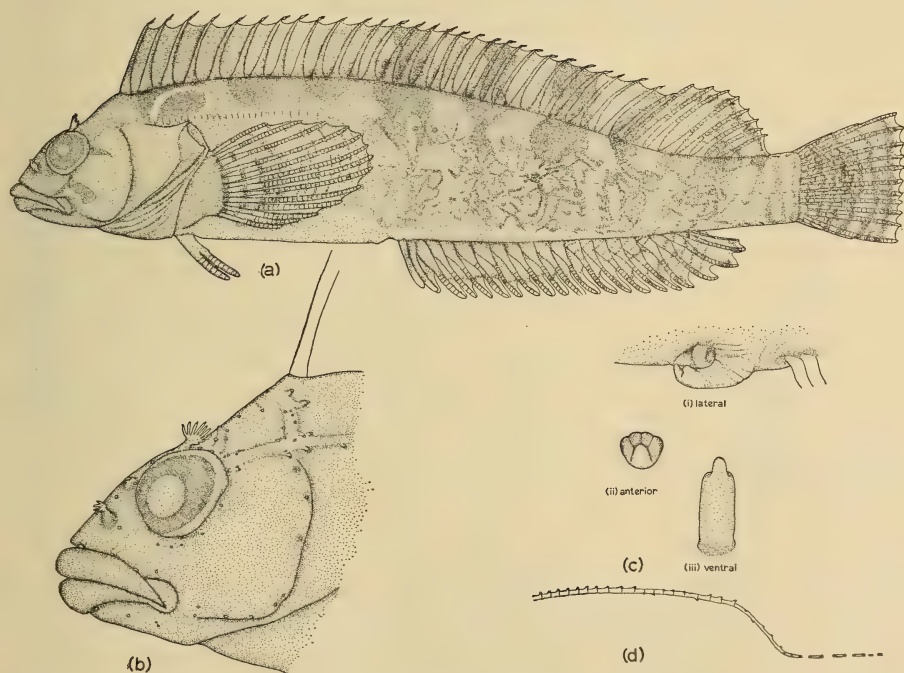


FIG. 18. *Clinus (Clinus) heterodon*: (a) Lateral view, female, 124 mm, S.A.M. 24671; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Remarks. The re-examination of Valenciennes' types indicated that the type-specimen of the species that he named *heterodon* was a tentacled clinid referable to the genus *Clinus*. It is in no way identifiable with the species for which the name *heterodon* has been used in South African literature since Barnard (1927)

identified it as such from Valenciennes' very brief description. The description is very inadequate and, translated, reads 'I did not see a tentacle over the eye . . .'. It has naturally been assumed, as it happens, incorrectly, that the specimen he examined did not have a tentacle over the eye. Gilchrist & Thompson (1908) did not identify any of the South African species they collected and described with Valenciennes' *C. heterodon*. However, Barnard (1927), assuming the lack of a supraorbital tentacle, and using the dorsal and anal fin counts given by Valenciennes for *C. heterodon*, identified a species of weed-dwelling clinid described by Gilchrist & Thompson under the name *Clinus graminis* as Valenciennes' *heterodon*. This identification has been followed by subsequent workers, so that the name *heterodon* has come to be applied to a species of the genus *Pavoclinus* (Smith, 1945, 1949).

The species to which Valenciennes' type and description of *C. heterodon* refer is fairly common on the west coast of South Africa.

Owing to its superficial similarity in fin counts to *C. acuminatus* it was not rediscovered until recently, and was described as a new species *Clinus obtusifrons* (Penrith, 1967). However, since my specimens of *obtusifrons* agree in every

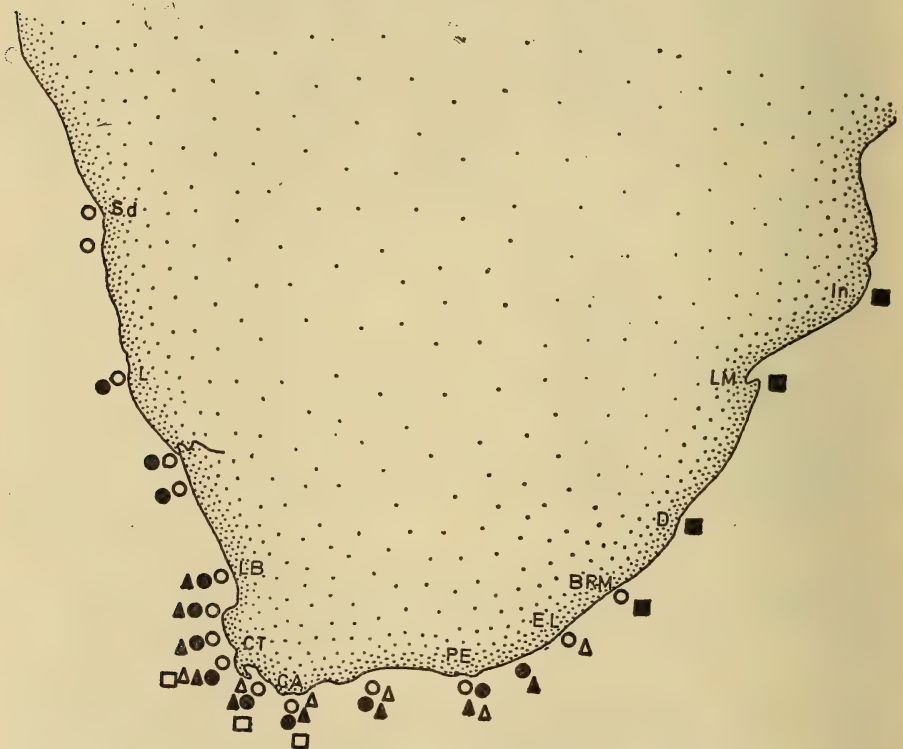


FIG. 19. Distribution of *C. latipennis* (open squares), *C. robustus* (open triangles), *C. superciliosus* (open circles), *C. taurus* (closed triangles), *C. venustis* (closed circles), *C. woodi* (closed squares).

way with Valenciennes' holotype of *C. heterodon*, the name *heterodon* must replace *obtusifrons*. The name *graminis* Gilchrist & Thompson is revived for the species that has been masquerading under the name of *heterodon* in the South African literature.

Clinus heterodon has very similar dorsal counts to *Clinus acuminatus*, but can be distinguished from that species by the shape of the intromittent organ, the shape of the snout and profile, the height of the first three dorsal spines, the greater width of the interorbital, and the number of pectoral rays. Large specimens of *Clinus obtusifrons* can be distinguished from *Clinus acuminatus* by the concave interorbital and the supraorbital ridges. The intromittent organ is similar to the type found in *Clinus berrisfordi*, *Clinus cottoides*, and *Clinus brevicristatus*.

Distribution (fig. 11). The known range is from north of Swakopmund ($22^{\circ}40'S$, $14^{\circ}34'E$) (South West Africa) to False Bay ($\pm 34^{\circ}10'S$, $18^{\circ}50'E$). The species is fairly common in pools in the middle and lower regions of the intertidal zone on the coast west of Cape Point, particularly from the Olifants River to the Orange River, but is extremely rare in False Bay.

Clinus (Clinus) latipennis Valenciennes in
Cuvier & Valenciennes, 1836
(Fig. 20)

Clinus latipennis Valenciennes in Cuvier & Valenciennes, 1836: 394. Barnard, 1927: 860. Hubbs, 1952: 106. Smith, 1966: 73.

Clinus latipinnis: Gilchrist & Thompson, 1908, 127.

Labrisomus latipennis: Swainson, 1839: 277.

Ophthalmolophus latipinnis: Gill, 1860: 104. Smith, 1945: 542.

Ophthalmolophus latipennis: Smith, 1949: 355, fig. 993.

Description. D. XXXIII-XXXVI 8-9; A. II 23-26; P. 13-14; V. I 2-3; C. 13. Vertebrae 17 + 30-33. Dorsal fin low, even; no notch in membrane between third and fourth dorsal spines. No clusters of cirri at tips of dorsal spines. Pectoral fin rounded. Inner pelvic ray minute or absent. Caudal peduncle short, length 27.5-33.3% head length, depth 20-33% head length. Caudal fin subtruncate.

Body slightly compressed, covered with small embedded scales extending on to dorsal fin base; caudal and anal fin bases and head naked. Depth 4.85-5.2 in standard length. Head 3.5-5.5 in standard length, snout bluntly rounded. Interorbital grooves moderately deep. Eye 3.2-4.6 in head. Supra-orbital tentacle prominent, with flattened stalk, expanded tip, and terminal fringe of fine filamentous cirri. Cirrus on anterior nostril flattened, narrow at base with expanded trilobate tip. Upper jaw 35-43.5% standard length. Lips moderately thin. Vomer toothed. Sensory pores of head single in nasal and interorbital series, single except for first pore in mandibular series, and double in preopercular series; double or multiple in remaining series (fig. 20(b)). Many pores open on papillae, giving head a rough appearance.

Lateral line of vertical pairs of pores in front to post-pectoral curve, then of

short separate horizontal tubes with pore at either end (fig. 20(d)). Intromittent organ of male with moderately long basal portion and swollen tip ensheathed by pair of large, flattened ventral lobes and small flattened dorsal lobe. Three lobes at base of organ, two lateral rounded ones and one dorsal flattened lobe (fig. 20(c)).

Colouring. Pinkish brown with faint irregular darker mottling and speckling. Fins whitish, dorsal with about seven dark cross bars not reaching upper edge of fin. Pectoral and caudal fins with clusters of small black dots forming irregular spots. Head grey-brown, mottled. A few white spots on pectoral base and along sides. Pattern remains for a long time after preservation.

Location of type material. Muséum National d'Histoire Naturelle, Paris.

Material examined. 7 specimens, 47–102 mm in standard length. 3 specimens, Cape, Paris Museum Cat. Nos. A2010, A2011, A2012 (syntypes); 1 from St. James, S.A.M. 10533; 2 from Die Dam, Bredasdorp district, S.A.M. 25066; 1 from Fish Hoek, December, 1966, S.A.M. 25067.

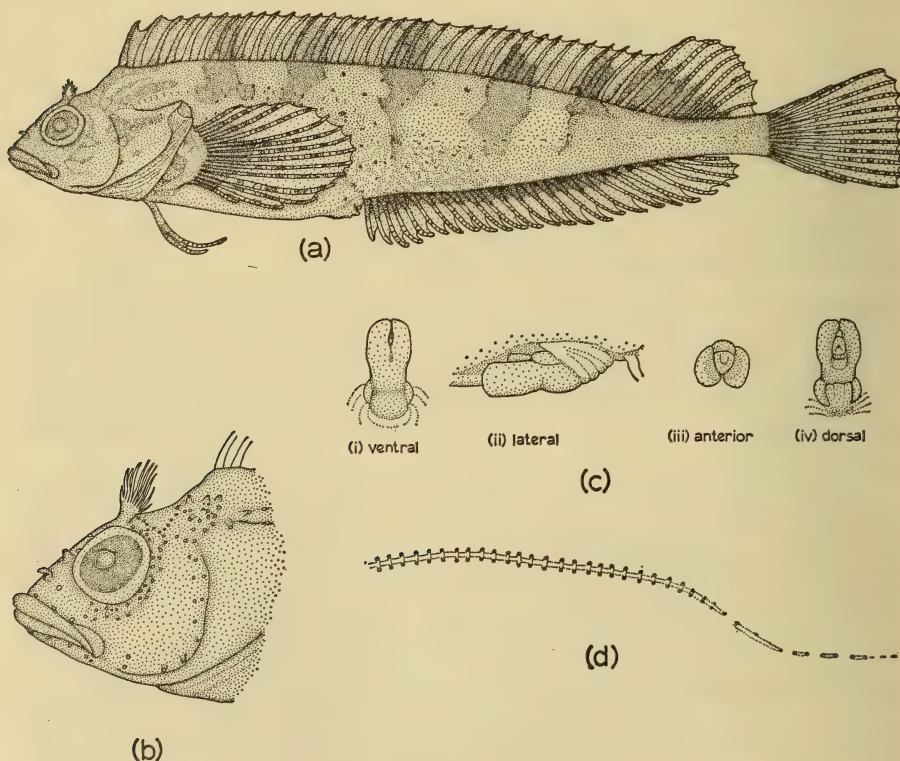


FIG. 20. *Clinus* (*Clinus*) *latipennis*: (a) Lateral view, female, 82 mm, S.A.M. 25066; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Remarks. This species is poorly known, although it was one of the earliest described South African Clinidae. There are four specimens in the South African Museum, three of which were acquired recently, so that fresh material was available for study. This species is extremely similar to *Clinus helenae*, particularly in the occurrence of basal lobes around the intromittent organ. It is distinguished from *Clinus helenae* in having more dorsal soft rays. It is very similar in appearance to *Clinus cottoides*.

Distribution (fig. 19). The known range is from Table Bay ($\pm 33^{\circ}45'S$, $18^{\circ}20'E$) to Cape Agulhas ($34^{\circ}50'S$, $20^{\circ}00'E$); rare.

Clinus (Clinus) robustus Gilchrist & Thompson, 1908

(Fig. 21)

Clinus robustus Gilchrist & Thompson, 1908: 128. Barnard, 1927: 850. Smith, 1945: 541, 1949: 354, pl. 81 fig. 987 and fig. 987.

Clinetrachus robustus: Hubbs, 1952: 107.

Caboclinus robustus: Smith, 1966: 73.

Description. D. XXXII-XXXIV (XXXIII) 9-14 (10-11); A. II 26-28 (26-27); P. 12; V. I 3; C. 13. Gill-rakers in outer series on first arch 1-2 + 4-5. Vertebrae 17 + 33. First three dorsal spines slightly elevated, forming low crest, second spine longest (first dorsal spine 0.5-4 mm longer than fourth dorsal spine). Shallow notch in membrane between third and fourth dorsal spines, depth variable (see table 3). Anterior dorsal spines with clusters of 3-4 cirri at tips. Inner pelvic ray well developed, at least half length and thickness of other rays. Caudal peduncle short, length 25-33.3% head length, depth 24-30% head length. Caudal fin subtruncate.

Body slightly compressed, covered with small embedded scales extending on to bases of dorsal and caudal fins but not anal fin base or head. Depth 4.5-5.5 in standard length. Head large, heavy, 3.25-4 in standard length, snout bluntly rounded in large specimens, somewhat subconical in smaller ones. Eye 5-7.5 in head. Supraorbital tentacle prominent, with flattened stalk and expanded flat tip, terminating in several short, flat, simple branches. Cirrus on anterior nostril somewhat elongate, narrower at base, margin irregularly indented. Mouth large, upper jaw 45.5-53.5% head length. Lips thick, with distinct vertical corrugations. Vomer toothed. Sensory pores of head double or multiple in suborbital, supraorbital, and occipital regions, otherwise mostly single (fig. 21(b)).

Lateral line of vertical pairs of pores and single pores opening above and below the line in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 21(d)). Intromittent organ of male with moderately long basal portion and two pairs of lips ensheathing tip, small rounded dorsal pair and large ventro-lateral pair, latter with finely serrate ventral margins (fig. 21(c)).

Colouring. Variable, olive yellow to dusky, with speckling in dark olive, red,

black, green, and white, forming obscure crossbars continuing on to dorsal and anal fins, or dark greyish brown with vague mottling. Sometimes a few bright orange speckles along anterior part of lateral line. Pectoral, pelvic, and caudal fins barred. Dorsal, anal, and pelvic fins red- or orange-tipped. Usually two dark radiating lines from eye across cheek. Uniform yellowish preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Female, 280 mm standard length, Seal Island, False Bay, S.A.M. 10539.

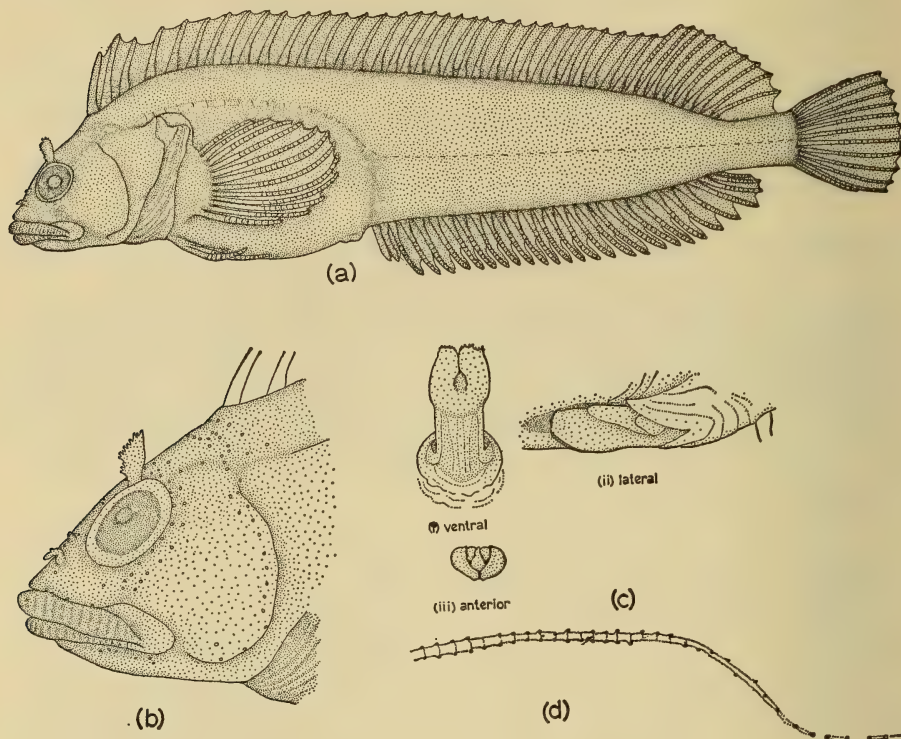


FIG. 21. *Clinus (Clinus) robustus*: (a) Lateral view, female, 121 mm, S.A.M. 23878; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Material examined. 12 specimens, 123–314 mm in standard length. 1 from Melkbosch, S.A.M. 24072; 8 from Kalk Bay, False Bay, S.A.M. 10537, S.A.M. 10538 (paralectotypes), S.A.M. 10539 (lectotype), S.A.M. 18087; 2 from Dalebrook, False Bay, S.A.M. 23873; 1 from St. James, False Bay, S.A.M. 12019.

Remarks. Although Smith (1945), and following him Hubbs (1952), treated *Clinus robustus* as if it were very close to *Clinus superciliosus*, the similarity in size

and habit between these two species probably accounted for this as much as actual resemblance, as the two species are not easily confused. *Clinus robustus* appears to be a rather primitive and generalized species; it is at least as closely related to forms such as *Clinus taurus* and *Clinus agilis* as to *Clinus superciliosus*, and at smaller sizes bears a superficial resemblance to large specimens of *Clinus acuminatus*.

Distribution (fig. 19). The known range is west coast of the Cape Peninsula ($34^{\circ}21'S.$, $18^{\circ}29'E$) to East London ($33^{\circ}00'S.$, $27^{\circ}54'E$). Fowler (1934) recorded this species from Natal, but its occurrence there is most improbable. The validity of all Fowler's (1934) clinid records is doubtful. Infratidal except in the young stages. Appears to be rare.

Clinus (*Clinus*) *superciliosus* (Linnaeus, 1758)
(Fig. 22)

Blennius superciliosus Linnaeus, 1758: 257.

Blennius mustelaris Linnaeus, 1758: 257. Gronovius, ed. Gray, 1854: 98 (*mustellaris*).

Blennius punctulatus Lacépède, 1800: 460.

Blennius mustela Lacépède, 1800: 459.

Blennius spadiceus Bloch & Schneider, 1801: 172.

Blennius capensis Forster, in Bloch & Schneider, 1801: 175.

Clinus superciliosus: Cuvier, 1817: 173. Valenciennes in Cuvier & Valenciennes, 1836: 360.

Gilchrist & Thompson, 1908: 113. Thompson, 1918: 149. Barnard, 1927: 855. Smith, 1945:

541, 1949: 354, pl. 77 fig. 986 and fig. 986.

Clinitrachus superciliosus: Swainson, 1839: 276. Hubbs, 1952: 106 (*Clinetrachus*).

Blennius versicolor Pappe, 1853: 27.

Blennius mycterizans Gronovius, ed. Gray, 1854: 97.

Blennius ignobilis Gronovius, ed. Gray, 1854: 96.

Clinus dubius Castelnau, 1861: 51.

Clinus pantherinus Castelnau, 1861: 52.

Clinus marmoratus Castelnau, 1861: 52.

Clinus ornatus Gilchrist & Thompson, 1908: 116.

Clinus superciliosus var. *arborescens* Gilchrist & Thompson, 1908: 115.

Caboclinus superciliosus: Smith, 1966: 73.

Doubtful synonym: *Blennius varius* Seba, 1758: 90, 93.

Description. D. XXXI–XLII (XXXIV–XXXVI) 5–10 (7–8); A. II 21–30 (24–27); P. 15–18 (15–16); V. I 2; C. 13. Gill-rakers in outer series on first arch 2–3 + 7–8. Vertebrae 18 + 30–32. Dorsal fin with first three spines considerably elevated to form crest, higher in mature males than in females and juveniles (table 5). Notch of varying depth in membrane between third and fourth dorsal spines (table 3). Pectoral fin rounded. Third pelvic ray invariably absent; present in two specimens of whole sample examined. Caudal peduncle short, length 24–26.5% head length, depth 29–33.5% head length. Caudal fin subtruncate. Clusters of cirri usually present at tips of first three dorsal spines.

Body slightly compressed, covered with small embedded scales, more or less overlapping at least on front half of body, extending on to dorsal and caudal fin bases; anal fin base and head naked. Depth 4–5 in standard length. Head 3.25–4 in standard length, snout conical to rounded in large specimens. Eye

2.5–3.75 in head. Supraorbital tentacle variable, usually small, with narrow subcylindrical stalk and flattened spatulate tip with a few short, simple branches, but occasionally more prominent, with fairly long subcylindrical stalk giving off many fine filamentous branches towards tip. Cirrus on anterior nostril small, flaplike. Upper jaw 33–55.5% head length, increasing with increase in standard length. Lips thick. Vomer toothed. Sensory pores of head mostly single, double in occipital and supraorbital series (fig. 22(b)).

Lateral line of single and few vertical pairs of pores in front to post-pectoral curve, then of short separate horizontal tubes with pores at either end (fig. 22(d)). Intromittent organ of male with moderately long basal portion and tip ensheathed by complicated skinny fold, presumably derived from confluent ventral lips, with two flat dorsal lips above; appears square when retracted (fig. 22(c)).

Colouring. Very variable. Usually mottled and blotched pattern with conspicuous dark, roughly diamond-shaped blotches, lighter in centre, along base of, and continued on to, dorsal fin. Ground colour usually buff or grey, with red and darker mottling, but plain scarlet, crimson, bronze and green specimens with fine black speckling, and red, bright green, or olive specimens with the usual pattern in a darker shade occur. A round dark spot, which may appear metallic blue when fresh, on dorsal crest. Head dark above, barred and reticulated below with longitudinal stripes of lighter and darker shades, rising from lips to eye and curving down again across cheek. Dark, comma-shaped mark on opercle. Belly mainly white; may have reticulate markings. Branchiostegal membranes with reticulate markings. Fins irregularly barred; often with bright red and orange markings in mature males. Juveniles milky with faint dark marks along dorsal base. Pattern remains for years after preservation.

Location of type material. Unknown.

Material examined. 1,118 specimens, 29–251 mm in standard length. 57 from Swakopmund and Milestone 26, S.A.M. 24200; 56 from Walvis Bay, S.A.M. 1381, S.A.M. 9866, S.A.M. 24203; 127 from Lüderitzbucht, S.A.M. 24204; 28 from Port Nolloth, S.A.M. 24215; 1 from Kleinsee, Namaqualand, S.A.M. 18225; 17 from Hondeklip Bay, March 1965, S.A.M. not catalogued; 53 from Gert du Toit Bay and Doring Bay, southern Namaqualand, S.A.M. 24225; 417 from Lambert's Bay, S.A.M. 23905, S.A.M. 23914; 4 from Hoetjies Bay, Saldanha Bay, S.A.M. 9868, S.A.M. 9869; 9 from Saldanha Bay, S.A.M. 23970, S.A.M. 23911; 4 from Robben Island, Table Bay, S.A.M. 9859; 3 from Green Point, Cape Peninsula, S.A.M. 22779; 88 from Sea Point, S.A.M. 23912, S.A.M. 23915, and 17/2/1965, S.A.M. not catalogued; 1 from Hout Bay, Cape Peninsula, S.A.M. 23908; 2 from Kommetjie, Cape Peninsula, S.A.M. 9865; 32 from Froggy Pond and Miller's Point, False Bay, S.A.M. 23910; 8 from Kalk Bay, False Bay, S.A.M. 9875 (syntype of *ornatus*); 11 from Dalebrook, False Bay, S.A.M. 23913, S.A.M. 23916, S.A.M. 23917 and 18/4/1965 and 16/5/1965, S.A.M. not catalogued; 41 from Strandfontein, False Bay, S.A.M. 23977,

S.A.M. 24223; 10 from Strandfontein and Dalebrook, 19/2/1965, S.A.M. not catalogued; 9 from False Bay, S.A.M. 9871, S.A.M. 9872, S.A.M. 9873 (syntypes of var. *arborescens*), S.A.M. 9874 (syntype of *ornatus*); 51 from Onrust River Mouth, S.A.M. 23904, S.A.M. 24226; 13 from Die Dam, Bredasdorp district, S.A.M. 24507, S.A.M. 24547; 10 from Still Bay, S.A.M. 25070; 2 from Mossel Bay, S.A.M. 23909; 5 from Knysna (Leisure Isle and the Heads) S.A.M. 24227; 44 from Port Elizabeth, S.A.M. 23918, S.A.M. 23986, S.A.M. 24224; 2 from Kidd's Beach, East London, S.A.M. 25069; 3 from Kei Mouth, S.A.M. 25071.

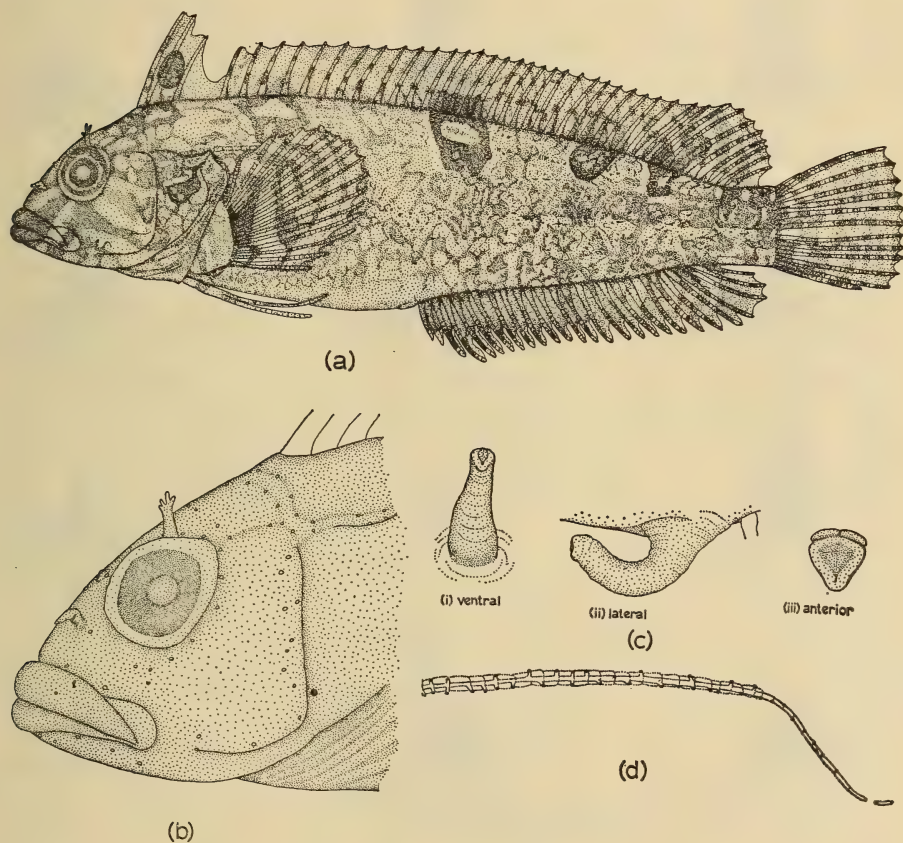


FIG. 22. *Clinus* (*Clinus*) *superciliosus*: (a) Lateral view, male, 82.5 mm, S.A.M. 23907; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Remarks. *Clinus superciliosus* is the most abundant South African clinid, and also, as suggested by the extensive synonymy, the most variable. *Clinus ornatus* was described by Gilchrist & Thompson (1908) for nine mature male specimens from Table Bay; these specimens had rather different markings from the typical

form, a better developed supraorbital tentacle, and the dorsal fin originating further forward than in the usual variety (see table 6). It seems that, as stated by Smith (1945), these specimens are simply an unusual variety of male *Clinus superciliosus*, and unless females and juveniles can be found to correspond with the *ornatus* males, they must be included in the species *superciliosus*. This species shows a stronger tendency to sexual dimorphism than the other South African clinid species, since, apart from the intromittent organ, the crest is

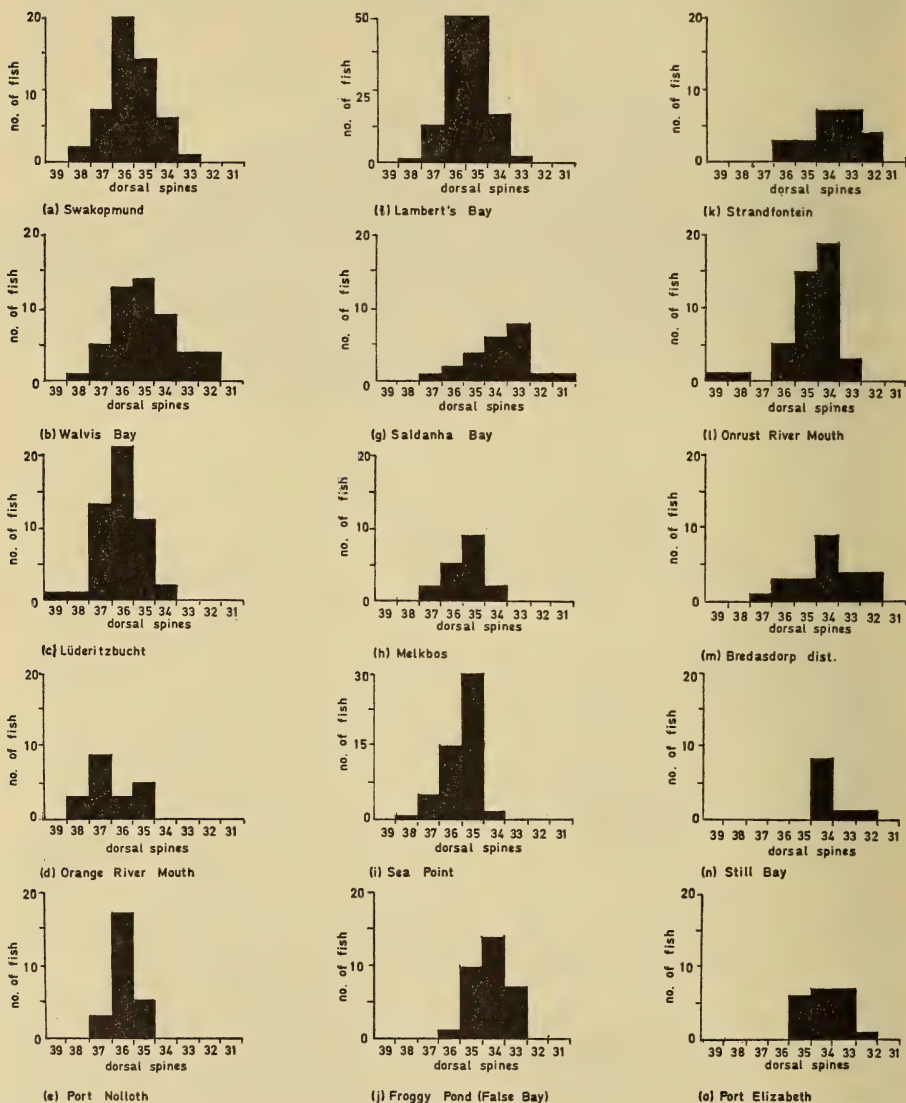


FIG. 23. Histogram showing dorsal spine count variation in different populations of *C. superciliosus*.

much higher in mature males than in females or juveniles, a condition not found in any of the other crested South African species (see table 5).

A variety of *Clinus superciliosus*, *C.s. arborescens*, was also described by Gilchrist & Thompson (1908) for specimens which have the larger, more filamentous type of tentacle over the eye, but this also appears to develop only in some mature males. A few specimens with tentacles of the *arborescens* type were taken in a large sample obtained from Onrust River mouth (January, 1963), and there were no other differences between them and the other specimens of the sample.

Clinus superciliosus resembles *Clinus woodi* most closely of all the species of *Clinus*, but has higher fin counts, and the dorsal fin origin further back (table 6). The crest of *Clinus woodi*, which is also high and well developed, does not appear to show sexual dimorphism. *Clinus superciliosus* resembles *Clinus robustus* mainly in the size attained and the habitat in which it occurs.

In a study of large samples of *Clinus superciliosus*, two variations that may be related to distribution have become apparent. The height of the crest of mature males appears to be greater east of Cape Point and the number of dorsal spines tends to be lower. The latter is shown in fig. 23. The crest requires further study, as no large mature males were obtained east of Hermanus, but there was a marked difference between Hermanus district specimens and specimens from Lambert's Bay, St. Helena Bay, Saldanha Bay and Sea Point on the coast west of the Cape Peninsula. Jackson (1950) also noted the occurrence of such variation in *Clinus superciliosus*, but did not give measurements. The fin counts, which do not vary with the size of the fish, show distinct variation from one population to another (fig. 23), and the east coast populations show on average a lower number of dorsal spines than the west coast populations.

Distribution (fig. 19). The known range is Rocky Point ($18^{\circ}59'S.$, $12^{\circ}29'E$) (South West Africa) to the Kei River ($32^{\circ}41'S.$, $28^{\circ}23'E$). The species is exceedingly common from Swakopmund to Port Elizabeth and less common northwards from Swakopmund and eastwards from Port Elizabeth. Intertidal and infratidal. Linnaeus (1758) gave the type locality as India, but as his description seems to pertain to the South African species described above, the locality he gave is certainly erroneous.

TABLE 5. Height of dorsal crest in *Clinus superciliosus*
Height of crest (% of standard length)

	10-12.9%	13-15.9%	16-18.9%	>19%
Females (no. of fish)	63	6	0	0
Juvenile males (no. of fish)	25	21	0	0
Mature males (no. of fish)	2	6	17	32

TABLE 6. Comparison of *Clinus superciliosus* (mature males) 'ornatus' males, and *Clinus woodi* (males and females) (Abbreviations: S.L. = standard length; H.L. = head length; Snt. = snout; D.O. = dorsal fin origin).

	S.L. (mm)	H.L. as % of S.L.	Snt.-D.O. as % H.L.
<i>superciliosus</i>	163	25.2	78.0
	165	26.6	79.5
	103	26.7	80.0
	112	24.0	96.5
	131	26.0	76.5
'ornatus'	70	24.2	67.5
	88.5	24.8	68.0
	72	25.7	70.5
	151	23.2	70.0
	166.5	22.8	70.0
	141	24.0	66.0
	177	23.8	62.0
<i>woodi</i>	167	22.8	68.5
	81	28.4	61.0
	96	29.2	59.0
	95	27.4	54.0
	112	27.6	61.0
	146	27.0	58.0

Clinus (Clinus) taurus Gilchrist & Thompson, 1908
(Fig. 24)

Clinus taurus Gilchrist & Thompson, 1908: 126. Barnard, 1927: 858.

Blenniomimus taurus: Smith, 1945: 539, 1949: 353, pl. 78 fig. 982.

Description. D. XXX-XXXVI (XXXII-XXXIV) 5-6; A. II 20-24 (21-23); P. 12; V. I 2-3; C. 13. Gill-rakers in outer series on first arch 3-4 + 7-8. Vertebrae 16 + 28-30. Dorsal fin low, even. Notch in membrane between third and fourth dorsal spines (table 3). No clusters of cirri at tips of dorsal spines. Pectoral fin rounded. Inner pelvic ray minute or absent. Caudal peduncle short, length 20-32% head length, depth 21-23.5% head length. Caudal fin subtruncate.

Body slightly compressed, tapering towards tail, covered with small embedded scales extending on to dorsal and caudal fin bases but not on to anal fin base or head. Depth 4-5 in standard length. Head very heavy, 3.5-4.25 in standard length. Snout bluntly rounded. Interorbital markedly concave, heavy bony ridges over eyes. Occipital groves deep. Eye 3-4.5 in head. Supraorbital tentacle prominent, with flattened stalk and terminal fringe of fine cirri, filamentous. Cirrus on anterior nostril small, flattened, flaplike. Mouth large, upper jaw 42-53% head length. Lips moderately thin. Vomer toothed. Sensory pores of head single in nasal and mandibular series except first, double mandibular pore; multiple in all other series (fig. 24(b)). Most pores open on raised papillae; head very rough.

Lateral line of vertical pairs of pores, with multiple pores in front to post-pectoral curve, then of short separate horizontal tubes with pore at each end

(fig. 24(b)). Intromittent organ of male with fairly long basal portion; pair of crescentic dorsal lips and pair of rounded, confluent ventral lips ensheathing slender tip (fig. 24(c)).

Colouring. Ground colour in the fresh specimens examined pale green or yellow, with about seven heavy dark brown cross-bars; head mottled with lilac. Fins orange-tipped. Plain yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Male, 154 mm standard length, St. James, no other data, S.A.M. 10451.

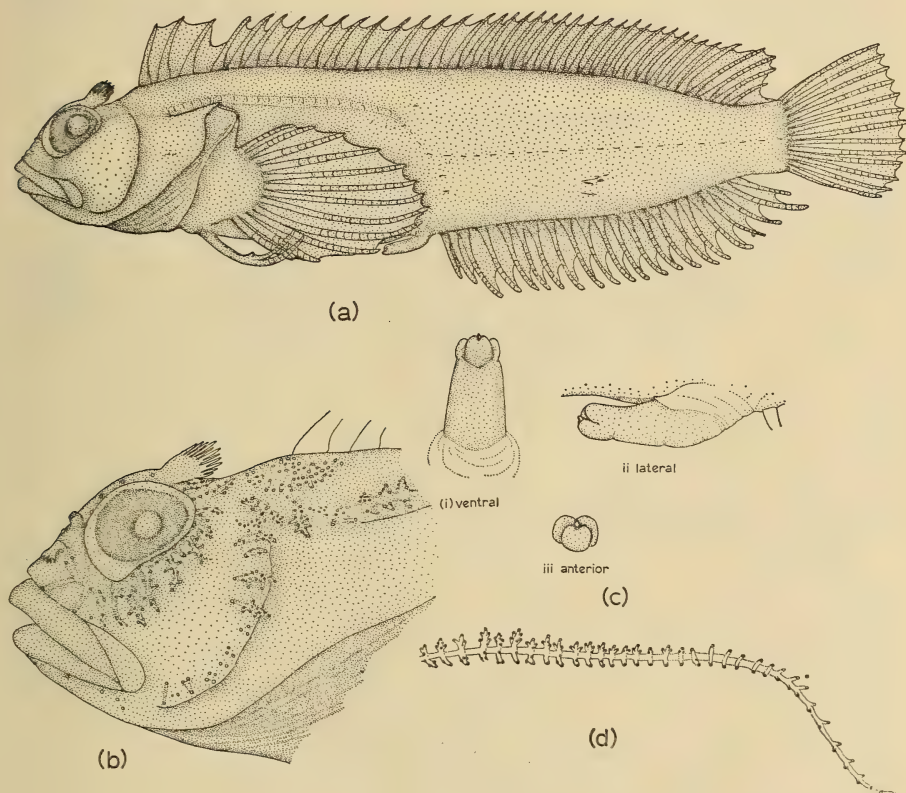


FIG. 24. *Clinus* (*Clinus*) *taurus*: (a) Lateral view, male, 116 mm, Dalebrook, 12/1/1966, S.A.M.; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Material examined. 17 specimens, 74–188.5 mm in standard length. 1 from Lambert's Bay, S.A.M. 24008; 1 from Kommetjie, Cape Peninsula, S.A.M. 10454 (paralectotype); 4 from Strandfontein, False Bay, S.A.M. 24234; 11 from False Bay, S.A.M. 10451 (lectotype), S.A.M. 10450, S.A.M. 10452, S.A.M. 10453 (paralectotypes), 2 specimens, Cape, Paris Museum Cat. No. A. 2077 (syntypes of *C. cottoides*).

Remarks. *Clinus taurus* resembles *Clinus cottoides*, *Clinus latipennis*, *Clinus helenae*, and *Clinus heterodon* in having a concave interorbital, and represents the greatest development of the bony supraorbital ridges. It attains a larger size than the other species with a concave interorbital, and differs from them in having notches in the membrane between the four or five anterior dorsal spines, deepest between the third and fourth spines. In these respects it resembles *Clinus robustus* more closely, although *Clinus robustus* has a crest. The head pore system and the anterior part of the lateral line have more numerous pores than any of the other species of the genus *Clinus*.

Distribution (fig. 19). The known range of this species is Lambert's Bay ($32^{\circ}04'S.$, $18^{\circ}20'E$) to Port Alfred ($33^{\circ}36'S.$, $26^{\circ}54'E$). It is rare, and occurs at the bottom of the intertidal zone and infratidally.

Clinus (Clinus) venustris Gilchrist & Thompson, 1908

(Fig. 25)

Clinus venustris Gilchrist & Thompson, 1908: 130. Barnard, 1927: 861. Smith, 1966: 73.

Ophthalmolophus venustris: Smith, 1945: 542. Smith, 1949: 355, fig. 990.

Description. D. XXXVII-XLI (XXXIX-XLI) 2-3; A. II 23-28 (24-27); P. 14; V. I 2; C. 13. Gill-rakers in outer series on first arch 3 + 6-8. Vertebrae 18 (rarely 17) + 28-31. First dorsal spine low, about equal to fourth; second, and to lesser extent third, dorsal spines elevated, second spine 0.5-3 mm higher than first or fourth spines. No notch in membrane between third and fourth dorsal spines, but second and third spines project above membrane. Clusters of 2-3 cirri at tips of dorsal spines for about half length of fin. Pectoral fin rounded. Third pelvic ray absent. Caudal peduncle short, length 26.5-33% head length, depth 23.5-29% head length. Caudal fin subtruncate.

Body slightly compressed, covered with small embedded scales not extending on to fin bases or head. Depth 4-5 in standard length. Head 3.75-4.75 in standard length, forehead sloping rather steeply to eyes. Snout bluntly rounded. Eye 2.25-3.75 in head, noticeably large. Supraorbital tentacle with short, flattish stalk and flattened tip ending in several short, simple branches. Cirrus on anterior nostril flattened and spoon-shaped, margin shallowly indented. Upper jaw 39-48% head length. Lips moderately thick. Vomer toothed. Sensory pores of head single in nasal and interorbital series, mainly single in mandibular, preopercular, and postorbital series, double in remaining series (fig. 25(b)).

Lateral line of vertical pairs of pores in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 25(d)). Intromittent organ of male with moderately long basal portion; confluent pair of dorsal lips and large pair of ventro-lateral lips, both with serrated inner margins, ensheathing slender tip (fig. 25(c)).

Colouring. Very variable. Specimens from the coast north of Lambert's Bay pale buff with brown streaks, speckles, and reticulations. Bright blue red-

edged spot over first three dorsal spines. Fins red-tipped, anal fin often entirely red. Branchiostegal membranes pale with fine black dots. Characteristic dark line along edge of united gill membranes. Four specimens taken at Sea Point were plain crimson. Uniform yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Male, 103 mm standard length, Fish Hoek, False Bay, S.A.M. 25238.

Material examined. 43 specimens, 40–106 mm in standard length. 13 from Lüderitzbucht, S.A.M. 24212; 2 from Port Nolloth, S.A.M. 24217; 1 from Hondeklip Bay, S.A.M. 25072; 1 from southern Namaqualand, S.A.M. 24017; 7 from Saldanha Bay, S.A.M. 18462; 4 from Sea Point, S.A.M. 23948 and 17/2/1965, S.A.M. not catalogued; 15 from Fish Hoek, False Bay, S.A.M.

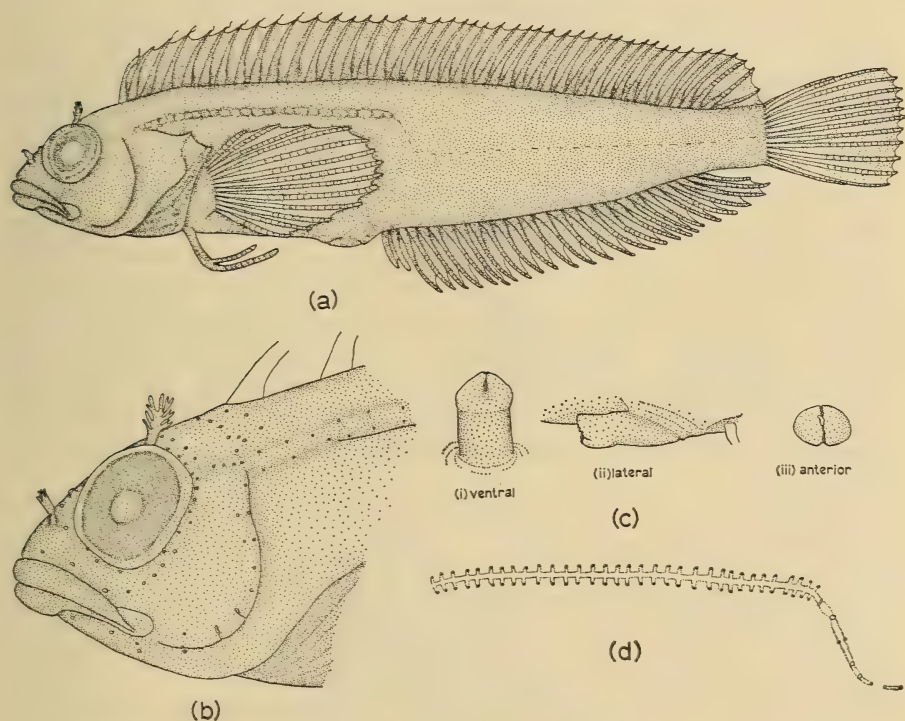


FIG. 25. *Clinus* (*Clinus*) *venustis*: (a) Lateral view, male, 91 mm, S.A.M. 25072; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

25238 (lectotype), S.A.M. 10543 (paralectotypes).

Remarks. This species is not strikingly similar to any of the other species of *Clinus*, and appears to be almost as close to forms such as *Clinus superciliosus* and *Clinus woodi* as to forms such as *Clinus acuminatus* and *Clinus agilis*. The form of the dorsal fin is different from that of any of the other species.

Distribution (fig. 19). The known range is from Lüderitzbucht (26°28'S., 15°10'E) (South West Africa) to Port Alfred (33°36'S., 26°54'E). This rare species occurs infratidally and in pools at the bottom of the intertidal region. It is taken intertidally more frequently west of Cape Point than from False Bay eastwards.

Clinus (Clinus) woodi (Smith, 1945)
(Fig. 26)

Petraites woodi Smith, 1945: 540, fig. 2, 1949: 353, pl. 77 fig. 984.

Description. D. XXVII–XXXI 5; A. II 21–24; P. 12–13; V. I 2; C. 13. Vertebrae 15 + 27. First three dorsal spines elevated, forming high, triangular crest; third and fourth dorsal spines widely separated, membrane from third spine barely reaches base of fourth (table 3). First dorsal spine originates far forward, over hind margin of eye (table 6). Clusters of cirri at tips of at least first three dorsal spines. Pectoral fin rounded. Third pelvic ray absent. Caudal peduncle short, length 21.5–33.5% head length, depth 21.5–23.5% head length. Caudal fin subtruncate.

Body slightly compressed, covered with small, embedded, more or less overlapping scales extending on to dorsal and caudal fin bases but not anal fin base or head, apart from three scales at upper anterior edge of opercle. Depth 3.5–4 in standard length. Head 3.5–4 in standard length, snout rounded, rather more conical in smaller specimens. Eye 3–4 in head. Supraorbital tentacle with cylindrical stalk giving off fine filamentous branches towards tip. Cirrus on anterior nostril short, flattened, bilobed. Mouth large, upper jaw 50–53.5% head length. Lips moderately thick. Vomer toothed. Sensory pores of head very small, single in nasal, interorbital and supraorbital series, mainly single in mandibular series; mainly double, occasionally multiple in remaining series (fig. 26(b)).

Lateral line narrow in front, difficult to see in detail, of vertical pairs of pores or single pores opening above or below line to post-pectoral curve, then of short separate horizontal tubes with pore at each end (fig. 26(d)). Pores very minute. Intromittent organ of male with fairly long basal portion; tip ensheathed by small pair of round dorsal lips and large pair of ventro-lateral lips, almost confluent, with constriction in centre (fig. 26(c)).

Colouring. No fresh specimens seen. Smith (1945) described the colouring as 'vivid in marbled olive, brown, and red, with obscure irregular cross-bars. One or two red oblique bars across cheek.' Uniform yellow preserved in alcohol.

Location of type material. Department of Ichthyology, Rhodes University, Grahamstown.

Material examined: 6 specimens, 81–146 mm in standard length. 1 from Xora Mouth, S.A.M. 24241; 5 from Xora Mouth, R.U.C. (paratypes).

Remarks. *Clinus woodi* appears to be very close to *Clinus superciliosus*. The range of distribution of these two species does not overlap, but they are clearly speci-

fically distinct. The male *Clinus superciliosus* described by Gilchrist & Thompson (1908) as *Clinus ornatus* approaches *Clinus woodi* in the forward displacement of the dorsal origin and the form of the supraorbital tentacle. The intromittent organ of *Clinus woodi* approaches the type found in *Clinus agilis*, and also is rather similar to that of *Clinus superciliosus*, in which the tip is surrounded by an almost continuous fold of skin.

Distribution (fig. 19). The known range is Kei Mouth ($32^{\circ}41'S.$, $28^{\circ}23'E$) to Inhambane ($23^{\circ}51'S.$, $35^{\circ}29'E$) (Mozambique). The species is said to be fairly common (Mrs. M. M. Smith, personal communication).

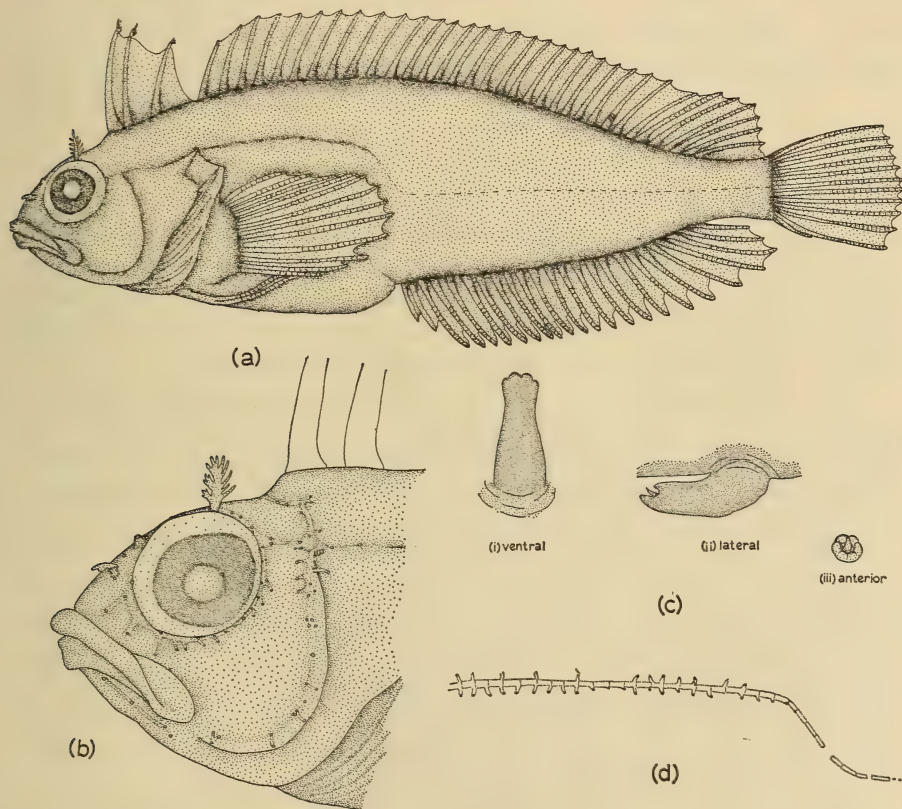


FIG. 26. *Clinus (Clinus) woodi*: (a) Lateral view, female, 112 mm, Xora Mouth, July 1962, R.U.C.; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Genus PAVOCLINUS Smith, 1945

Cristiceps non Valenciennes, Gilchrist & Thompson, 1908: 138 (type-species *Cristiceps australis* Valenciennes in Cuvier & Valenciennes, by monotypy).

Pavoclinus Smith, 1945: 545 (type-species *Clinus pavo* Gilchrist & Thompson, by original designation).

Labroclinus Smith, 1945: 544 (type-species *Cristiceps mentalis* Gilchrist & Thompson, by original designation).

Fucomimus Smith, 1945: 544 (type-species *Clinus mus* Gilchrist & Thompson, by monotypy).

Myxodes non Cuvier, Smith, 1945: 544 (type-species *Myxodes viridis* Valenciennes in Cuvier & Valenciennes, by monotypy).

Smithichthys Hubbs, 1952: 107 (type-species *Clinus fucorum* Gilchrist & Thompson, by monotypy).

Diagnosis. No tentacle over eye. Lateral line narrow in front, mainly of single pores opening medially or above and below line to post-pectoral curve, then of short separate horizontal tubes with pore at either end. Body covered with small cycloid scales, imbricating or not. Intromittent organ of male with short basal portion and very large conical tip surrounded at base by single pair of dorso-lateral lips. Body compressed, sometimes deep. Caudal peduncle usually elongate. Vomer toothed or not. Usually anterior crest of elevated first three dorsal spines, separated from rest of fin or not. Exclusively weed-dwelling species. Mouth fairly small, upper jaw averages less than 40% head length. No clusters of cirri at tips of dorsal spines.

Discussion

Smith (1945) arranged six species in four genera as follows:

1. *Pavoclinus*: forms with teeth on the vomer, and the first three dorsal spines elevated to form a crest, which is not separated from the rest of the fin by a notch in the membrane. Two species, *pavo* Gilchrist & Thompson and *graminis* Gilchrist & Thompson. Two additional species have subsequently been added to this group, *profundus* Smith, 1960 and *litorafontis* Penrith, 1965.
2. *Labroclinus*: forms with teeth on the vomer, and the first three dorsal spines elevated to form a crest, which is separated from the rest of the fin by a deep notch, the membrane from the third spine barely reaching the base of the fourth. Two species, *mentalis* Gilchrist & Thompson and *laurentii* Gilchrist & Thompson.
3. *Fucomimus*: forms lacking teeth on the vomer, with two bands of teeth in each jaw. One species, *mus* Gilchrist & Thompson.
4. *Myxodes*: forms lacking teeth on the vomer, with one row of teeth in the jaw. One species, *fucorum* Gilchrist & Thompson. Hubbs (1952) pointed out that, as *Myxodes* is a South American genus of oviparous Clinidae, lacking a fleshy penis in the male, and having external fertilization, *fucorum*, with a penis in the male and internal fertilization, cannot be a member of the genus *Myxodes*, and he proposed a new generic name, *Smithichthys*, for that species.

I believe that the features uniting the eight species mentioned above are too numerous and important to allow their separation into more than one genus, and they are therefore placed together in the genus *Pavoclinus*. I have used the name *Pavoclinus*, which contains all the most typical members of the genus, because this will necessitate the least number of alterations of name and additions to the synonymy. The names *Fucomimus* and *Labroclinus* have page preference over *Pavoclinus*. To use either *Fucomimus* or *Labroclinus* would result in extensive additions to the synonymy of the species. In the interest of maintaining the stability of the nomenclature, I therefore claim the privilege of the first reviser of the group to use *Pavoclinus* (International Commission for Zoological

Nomenclature, 1964, article 24(a), recommendation 24A).

The elongation of the caudal peduncle, compression of the body, and the coloration, including the frequently occurring translucent patches in the fin membranes, are presumably all modifications for a weed-dwelling existence. However, these similarities seem to be too many to be the result of convergence, and appear to indicate close relationship. *Clinus brevicristatus* and *Gynutoclinus rotundifrons* are also habitually weed-dwellers, but these two species do not share the features common to the *Pavoclinus* species. There is also considerable uniformity in the form of the intromittent organ of the *Pavoclinus* species. I believe that division of this group into more than one genus would obscure the relationships of the species.

Four subgenera are used to indicate the relationships of the species within the genus. Three of these are monospecific, and the fourth contains a closely related group of species.

The lack of vomerine teeth in the two species *mus* and *fucorum* appears to warrant their separation from the remaining species at a subgeneric level. Although it is possible that they are more closely related to one another than to any of the other species, *mus* and *fucorum* differ sufficiently from one another to justify the retention of *Smithichthys* and *Fucomimus* as separate subgenera. *Pavoclinus mus* differs from *P. fucorum* in having two rows of teeth in each jaw, the snout not upturned, the form and position of the dorsal fin origin, and in having 11 as opposed to 13 primary caudal rays (unique among the South African Clinidae).

The species *pavo*, *graminis*, and *laurentii* are so similar that even subgeneric distinction on account of the separation in *laurentii* of the dorsal crest seems unwarranted. However, the close association of *laurentii* with *mentalis* (Barnard, 1927; Smith, 1945), does not appear to be correct. *Pavoclinus graminis*, *P. pavo*, and *P. laurentii* all have fewer than 35 dorsal spines and fewer than 25 anal rays, while *P. mentalis* is markedly elongate, with a high number of dorsal and anal elements (35–39 dorsal spines and 29–30 anal rays). *P. mentalis* has a long skinny projection at the lower jaw symphysis, and reaches a very large size. On account of its peculiar features, and to emphasise the particularly close relationship between the species *pavo*, *graminis*, *laurentii*, *litorafontis*, and probably *profundus*, *mentalis* is placed in a separate subgenus *Labroclinus*.

Pavoclinus graminis and *P. laurentii* are the two least strongly modified species, having a fairly normal body shape rather like that of most species of the subgenus *Clinus* (*Clinus*). *Pavoclinus pavo* and *P. litorafontis* are somewhat more compressed, with rather longer caudal peduncles. It is proposed to include these four species in a subgenus *Pavoclinus*, together with, provisionally, *Pavoclinus profundus*, which is at present known only from the unique type.

The eight species of *Pavoclinus* are compared in table 7.

Distribution. West (26°38'S., 15°10'E) to east (23°51'S., 35°29'E) coasts of South Africa (fig. 27), mainly east of Cape Point, only one species, *Pavoclinus pavo*, occurring west of Cape Point. Mainly intertidal, in seaweed.



FIG. 27. Distribution of *P. mus* (open triangles), *P. fucorum* (closed triangles), *P. mentalis* (half-closed circles), *P. pavo* (open circles), *P. graminis* (closed circles), *P. litorafontis* (closed squares), *P. laurentii* (+), *P. profundus* (open square).

Key to the species of *Pavoclinus*

1. Vomer toothed 2
Vomer edentate 7
2. A prominent projecting flap of skin on the lower jaw at the symphysis
Pavoclinus (Labroclinus) mentalis
No flap of skin at lower jaw symphysis 3
3. First three dorsal spines raised to form a crest 4
First three dorsal spines not forming a crest *Pavoclinus (Pavoclinus) profundus*
4. Membrane from third dorsal spine barely reaches base of fourth
Pavoclinus (Pavoclinus) laurentii
Membrane from third dorsal spine reaches more than halfway up fourth 5
5. Inner pelvic ray stout, equal to others; 7-8 dorsal soft rays
Pavoclinus (Pavoclinus) litorafontis
Inner pelvic ray reduced; 6 or fewer dorsal soft rays 6
6. Dorsal soft rays 4-6; caudal peduncle less than 40% of head length; snout subconical
Pavoclinus (Pavoclinus) graminis
Dorsal soft rays 2-4; caudal peduncle more than 40% of head length; snout acute
Pavoclinus (Pavoclinus) pavo
7. Snout upturned, pug-like; one row of teeth in each jaw; caudal rays 13
Pavoclinus (Smithichthys) fucorum
Snout normal; 2 rows of teeth in each jaw; caudal rays 11 *Pavoclinus (Fucomimus) mus*

Subgenus *Fucomimus* Smith, 1945

Fucomimus Smith, 1945: 544 (type-species *Clinus mus* Gilchrist & Thompson).

Diagnosis: Vomer edentate; two rows of teeth in each jaw. First three dorsal spines elevated to form crest. Membrane from third spine barely reaches base of fourth. Snout not puglike. Body highly compressed. Scales minute, embedded, non-imbricating. Lateral line scales not distinct. Caudal peduncle long. Caudal rays 11.

One species, *Pavoclinus* (*Fucomimus*) *mus* (Gilchrist & Thompson).

Pavoclinus (*Fucomimus*) *mus* (Gilchrist & Thompson, 1908)
(Fig. 28)

Clinus mus Gilchrist & Thompson, 1908: 119. Barnard, 1927: 864.

Fucomimus mus: Smith, 1945: 544, 1949: 356, pl. 79 fig. 997 and fig. 997.

Description. D. XXV-XXVIII (XXVI-XXVII) 3-4 (3); A. II 14-18 (15-17); P. 10; V. I 3; C. 11. Gill-rakers in outer series on first arch 3-4 + 5-7. Vertebrae 14 + 27-28. First three dorsal spines elevated to form low crest, well separated from rest of fin by wide gap between third and fourth dorsal spines; membrane from third dorsal spine barely reaches base of fourth. Pectoral fin rather narrow, upper edge straight. Inner pelvic ray always present, about half length and diameter of other two rays. Dorsal fin with translucent membranes between groups of 2-4 spines. Caudal peduncle long, length 60-75% head length, depth 24-27.5% head length. Caudal fin subtruncate.

Body highly compressed, covered with minute, embedded, isolated scales not extending on to dorsal, caudal, or anal fin bases, or head. Depth 3.5-4.5 in standard length, deepening with increase in standard length. Head 3.75-5 in standard length, snout rounded. Eye 2.5-4 in head. No supraorbital tentacle. Cirrus on anterior nostril slightly elongate, curved forward over nostril. Upper jaw 27-33.5% head length, mouth small. Lips moderately thick. Vomer edentate. Sensory pores of head mostly single in all series (fig. 28(b)).

Lateral line narrow in front, of single, more or less medially opening pores to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 28(c)). Intromittent organ of male with short thick basal portion, long, fairly slender conical tip, and pair of lobed dorso-lateral lips (fig. 28(b)).

Colouring. Very variable. Ground colour various shades of green or brown, mottled and streaked in intricate patterns with yellow, mauve, olive, black, white, dark green, dark brown, and silver. Dorsal and caudal fins with translucent patches. Other fins green or brown. Belly not lighter than general ground colour. Juveniles uniform dark brown. Uniform yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Male, 75 mm standard length, St. James, Kalk Bay, no other data, S.A.M. 25233.

Material examined. 310 specimens, 22–86 mm in standard length. 2 from Froggy Pond, False Bay, S.A.M. 23893; 1 from Glencairn, False Bay, S.A.M. 23883; 2 from Kalk Bay, False Bay, S.A.M. 17936, S.A.M. 18075; 82 from Dalebrook, False Bay, S.A.M. 23880, S.A.M. 23895, S.A.M. 23897, and 18/12/1964, 19/2/1965 and 18/4/1965, S.A.M. not catalogued; 9 from St. James, Kalk Bay, False Bay, S.A.M. 25233 (lectotype), S.A.M. 10531 (paralectotypes); 11 from St. James, False Bay, S.A.M. 12021, and 16/5/1965, S.A.M. not catalogued; 173 from Strandfontein, False Bay, S.A.M. 23879, S.A.M. 23884, S.A.M. 23961, S.A.M. 23973, S.A.M. 24246, and 19/2/1965 S.A.M. not catalogued; 4 from Strandfontein and Dalebrook, False Bay, S.A.M. 23882; 1 from Cape Peninsula, S.A.M. 23890; 1 from Gordon's Bay, False Bay, S.A.M. 23292; 9 from Onrust River Mouth, S.A.M. 24247; 6 from Still Bay, S.A.M. 25073; 1 from Kidd's Beach, East London, S.A.M. 25074; 1 from Igoda Mouth, East London, S.A.M. 25075; 4 from Gonubie Mouth, East London, S.A.M. 25076; 3 from Kei Mouth, S.A.M. 25077.

Remarks. *Pavoclinus mus* is a highly modified weed-dwelling species. The deep, strongly compressed body and the elongate caudal peduncle are like those of *Pavoclinus fucorum*. I consider the difference in dentition important enough in conjunction with other features to separate *mus* and *fucorum* at the subgeneric

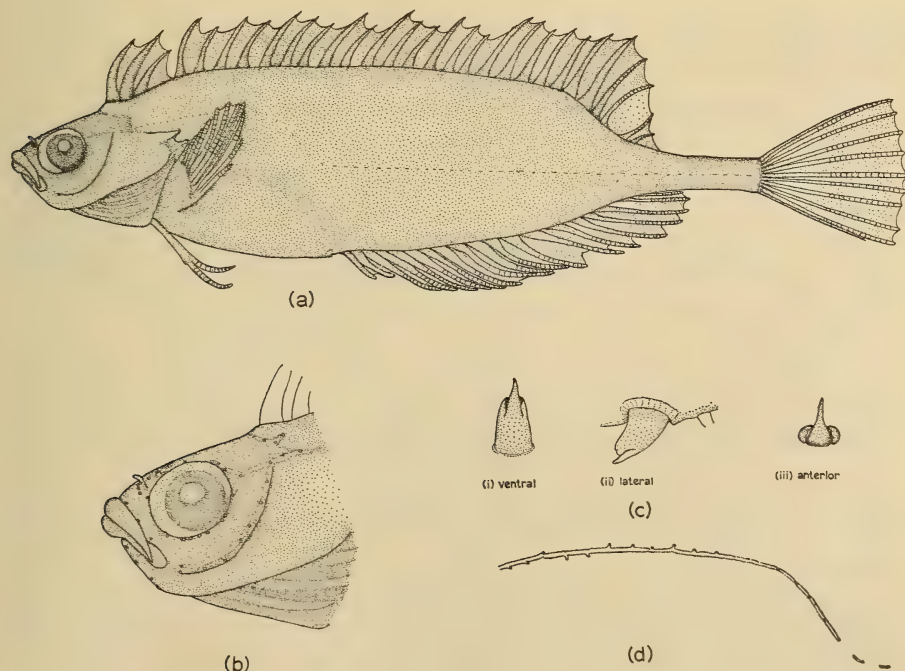


FIG. 28. *Pavoclinus (Fucominus) mus*: (a) Lateral view, female, 61 mm, Strandfontein, 19/2/1965, S.A.M.; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

level, especially since *Pavoclinus mus* has on the whole as many or more features in common with the species placed in the subgenus *Pavoclinus* than with *Pavoclinus fucorum*. *Pavoclinus mus* is rather similar to *Pavoclinus pavo* in having an extremely small mouth, a similar, although more exaggerated, body shape, and a rather delicate build compared with the other species.

Distribution (fig. 27). The known range is False Bay ($\pm 34^{\circ}10'S.$, $18^{\circ}50'E$) to the Kei River ($32^{\circ}41'S.$, $28^{\circ}23'E$). Quite abundant in dense growths of seaweed, particularly in the green alga *Caulerpa filiformis*, intertidal.

Subgenus *Labroclinus* Smith, 1945

Labroclinus Smith, 1945: 544 (type-species *Cristiceps mentalis* Gilchrist & Thompson).

Diagnosis: Vomer toothed; two rows of teeth in each jaw. First three dorsal spines form high crest. Membrane from third dorsal spine barely reaches base of fourth. Anal rays more than 25. Scales overlapping on anterior half of body. Caudal rays 13. Prominent skinny flap on lower jaw symphysis.

One species *Pavoclinus* (*Labroclinus*) *mentalis* (Gilchrist & Thompson).

Pavoclinus (*Labroclinus*) *mentalis* (Gilchrist & Thompson, 1908)

(Fig. 29)

Cristiceps mentalis Gilchrist & Thompson, 1908: 139.

Petraites mentalis: Barnard, 1927: 866.

Labroclinus mentalis: Smith, 1945: 544, 1949: 357, pl. 81 fig. 998.

Description. D. XXXV-XXXIX (XXXVI-XXXVII) 6-8 (6-7) A. II 27-32 (29-30); P. 11-12; V. I 3; C. 13. Vertebrae 16 + 37. First three dorsal spines elevated to form crest, separated from rest of fin by wide gap between third and fourth dorsal spines. Membrane from third dorsal spine barely reaches base of fourth. Pectoral fin with upper edge more or less straight. Inner pelvic ray stout, equal to others. Caudal peduncle fairly long, length 35-40% head length, depth 20-25% head length. Caudal fin subtruncate.

Body highly compressed, covered with small embedded scales extending on to dorsal and caudal fin bases but not anal base or head, more or less overlapping on front half of body. Depth 4.5-5.5 in standard length. Head 4-4.75 in standard length, snout narrowly pointed. Eye 4.25-5.75 in head. No supra-orbital tentacle. Cirrus on anterior nostril small, flaplike over nostril. Upper jaw 35-40% head length. Lips thick. Prominent flap of skin on lower jaw at symphysis. Vomer toothed. Sensory pores of head mostly single, occipital series double (fig. 29(b)).

Lateral line of mainly single pores opening above or below line or medially in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 29(d)). Intromittent organ of male with short basal portion and large conical tip with pair of crescentic dorso-lateral lips ensheathing it at base (fig. 29(c)).

Colouring. No fresh specimens seen. According to Smith (1949), 'most vivid and brilliant colouring, rather varied, aptly named 'Rainbow-fish'. The young with brilliant silvery iridescent spots along body'. Uniform yellowish preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Material examined. 8 specimens, 131–224 mm in standard length. 1 from East London, S.A.M. 9889 (holotype); 4 from East London, R.U.C.; 2 from Bizana Coast, R.U.C.; 1 from Xora Mouth, R.U.C.

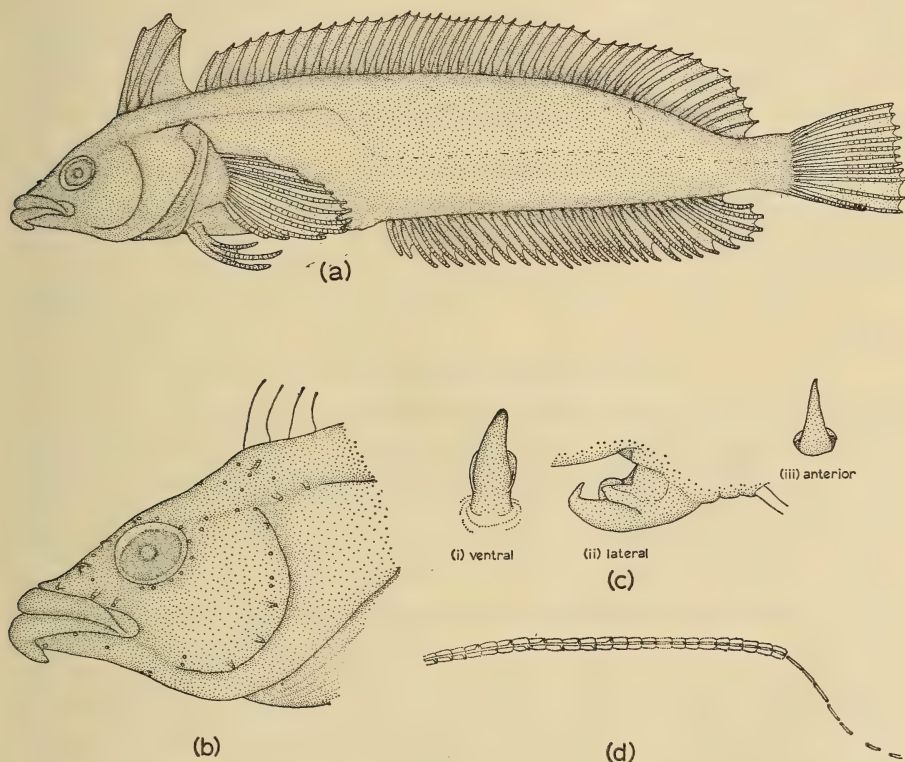


FIG. 29. *Pavoclinus* (*Labroclinus*) *mentalis*: (a) Lateral view, female, 165 mm, East London, R.U.C.; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Remarks. *Pavoclinus mentalis* was placed by Gilchrist & Thompson (1908) in the genus *Cristiceps* Valenciennes on account of its fully separated dorsal crest, although the same authors placed all the other South African Clinidae then described in the genus *Clinus*. The genus *Cristiceps* is Australasian and the species included in it are characterised by a high, sickle-shaped separate dorsal crest originating well forward over the eye, an elongate, very slender caudal peduncle, and a long, simple tentacle over the eye. *Pavoclinus mentalis* has no supraorbital tentacle, the crest originates in the usual position over the hind

margin of the preopercle, and the caudal peduncle, although somewhat elongate, is not very slender. The species therefore can not be included in the genus *Cristiceps*.

Barnard (1927) commented on the similarity between *mentalis* and *laurentii* and placed them in the genus *Petraites*, also Australian. *Petraites* has a fringed supraorbital tentacle and is probably not distinct from *Clinus*, so that the inclusion of *mentalis* and *laurentii* in *Petraites* was unsuitable. In 1945 Smith erected the genus *Labroclinus* for *mentalis* and *laurentii*. The association of *mentalis* and *laurentii* by these authors appears to have been based entirely on the separation of the dorsal crest, and may also have been influenced by the very similar distribution of the two species. As has been pointed out, neither of these species should be separated from the species of the genus *Pavoclinus*, but *mentalis* is considered to differ sufficiently from *laurentii* and the other species to warrant subgeneric separation.

When Smith (1945) designated *mentalis* as type-species of *Labroclinus* he cited it as '*Clinus*' *mentalis* Gilchrist & Thompson, but this is incorrect, as the name *Clinus* had never been used for *mentalis*.

Distribution (fig. 27). The known range is Port Alfred (33°36'S., 26°54'E) to St. Lucia Bay (28°23'S., 32°25'E). The species is rare, and occurs infratidally as well.

Subgenus *Pavoclinus* Smith, 1945

Pavoclinus Smith, 1945: 545 (type-species *Clinus pavo* Gilchrist & Thompson).

Diagnosis. Vomer toothed; two rows of teeth in each jaw. First three dorsal spines forming crest or not. With or without notch in membrane between third and fourth dorsal spines. Scales usually overlapping on at least front half of body. Body compressed. Caudal rays 13. No skinny flap on lower jaw symphysis. Anal rays less than 25.

Five species. *Pavoclinus graminis* is the most generalized species, having the shortest caudal peduncle and the least compression of the body. *Pavoclinus laurentii* has a rather longer caudal peduncle but is also not greatly compressed. *Pavoclinus pavo* and *Pavoclinus litorafontis* are highly compressed forms with an elongate caudal peduncle. *Pavoclinus profundus* is a peculiar infratidal species known only from the holotype; it resembles the other species of this subgenus more closely than it does any of the other clinids, but the dorsal fin is without any crest and the caudal peduncle is quite short.

Pavoclinus (Pavoclinus) graminis (Gilchrist & Thompson, 1908)

(Fig. 30)

Clinus graminis Gilchrist & Thompson, 1908: 136.

Clinus heterodon non Valenciennes in Cuvier & Valenciennes, Barnard, 1927: 863. Smith, 1935: 217.

Pavoclinus heterodon: Smith, 1945: 545, 1949: 357, pl. 80 figs 1001.

Description. D. XXX-XXXV (XXXII-XXXIII) 4-6 (5); A. II 21-24 (22-23); P. 12; V. I 3; C. 13. Gill-rakers in outer series on first arch 2-3 + 4-5. Verte-

brae 15 + 29-31. First three dorsal spines elevated to form crest, fairly low, second spine highest. No notch in membrane between third and fourth dorsal spines. Pectoral fin with upper edge more or less straight. Inner pelvic ray slender, about half length and diameter of others. Caudal peduncle moderate, 26.5-38.5% head length, depth 26-31% head length. Caudal fin subtruncate.

Body moderately compressed, covered with small embedded scales extending on to dorsal and caudal fin bases but not anal fin base or head, overlapping over whole body surface. Depth 4-5 in standard length. Head 3.5-4.75 in standard length, snout rounded to bluntly conical. Eye 2.5-3.75 in head. No supraorbital tentacle. Cirrus on anterior nostril very small, flaplike, covering nostril. Upper jaw 30-36% head length, mouth small. Lips moderately thick. Vomer toothed. Sensory pores of head mainly single in nasal, interorbital, mandibular and preopercular series, double or multiple in other series (fig. 30(b)).

Lateral line of single pores opening above or below line in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 30(d)). Intromittent organ of male with short basal portion and large conical tip emerging between pair of curved more or less confluent dorso-lateral lips (fig. 30(c)).

Colouring. Very variable, green, brown, red, often mottled, streaked or with cross-bars of yellow, silver, or deeper shades of the ground colour; pearly spots on body in young specimens, which are usually otherwise plain red. Fins plain or barred, with small translucent areas particularly on dorsal and caudal fins. Belly usually not lighter than ground colour. Colours tend to be brighter and more variable further east along the coast. Uniform yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Female, 126 mm, St. James, donated by Mr. Langschmidt, S.A.M. 25240.

Material examined. 100 specimens 24-141 mm in standard length. 1 from Miller's Point, False Bay, S.A.M. 23899; 8 from Dalebrook, False Bay, S.A.M. 23896, S.A.M. 23900 and 18/12/1964 and 18/4/1965 S.A.M. not catalogued; 12 from St. James, S.A.M. 25240 (lectotype), S.A.M. 10523 (paralectotypes) and 16/5/1965, S.A.M. not catalogued; 12 from Strandfontein, False Bay, S.A.M. 23885, S.A.M. 23901, S.A.M. 24249; 4 from Still Bay, S.A.M. 25078, 4 from Kidd's Beach, East London, S.A.M. 25079; 4 from Igoda Mouth, East London, S.A.M. 25080; 22 from East London, S.A.M. 23903, S.A.M. 25081; 4 from Gonubie Mouth, S.A.M. 25083; 17 from Port St. John's, S.A.M. 23902.

Remarks. *Clinus heterodon* was described from the Cape by Valenciennes (1836), and listed by Gilchrist & Thompson (1908), who stated that they had not rediscovered the species here. Barnard (1927) identified the specimens from which they described *graminis* as *C. heterodon* of Valenciennes. However, the original description of *C. heterodon* was so inadequate that one could not base

an identification on it without examining the holotype. I found that the holotype is a tentacled clinid of the genus *Clinus*. Gilchrist & Thompson's name *graminis* therefore stands for the species of the genus *Pavoclinus* described above.

Distribution (fig. 27). The known range is False Bay ($\pm 34^{\circ}06'S.$, $18^{\circ}50'E$) to Inhambane ($23^{\circ}51'S.$, $35^{\circ}29'E$) (Mozambique), becoming more common eastwards. Usually intertidal, in weed. Smith (1945 and 1949) gave Port Nolloth as the north-western limit of this species, but its occurrence anywhere west of Cape Point has not been confirmed, and it seems certain that the record was an error.

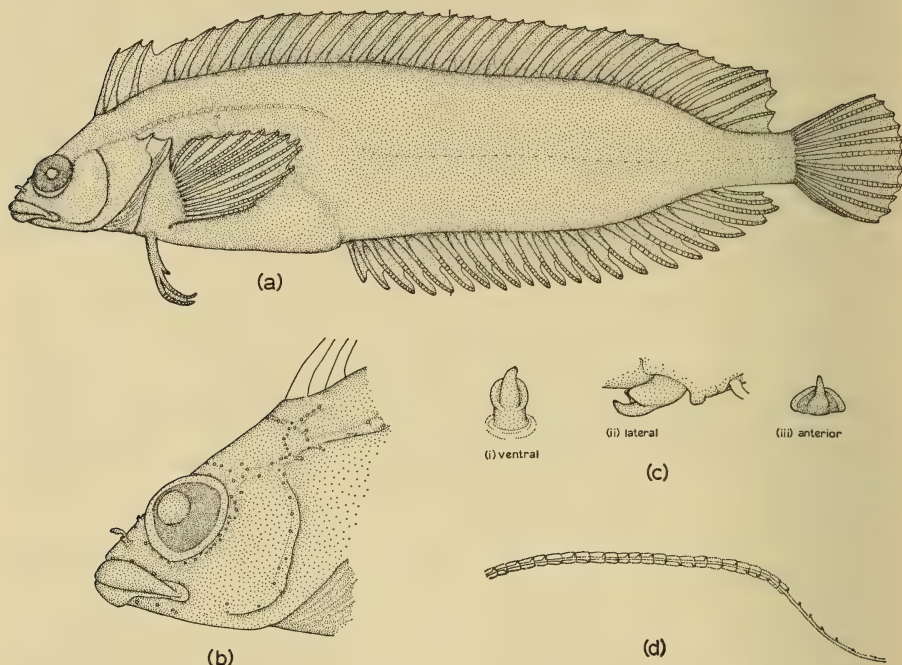


FIG. 30. *Pavoclinus* (*Pavoclinus*) *graminis*: (a) Lateral view, female, 115 mm, S.A.M. 25083 (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Pavoclinus (*Pavoclinus*) *laurentii* (Gilchrist & Thompson, 1908)
(Fig. 31)

Clinus laurentii Gilchrist & Thompson, 1908: 120. Smith, 1935: 218, fig. 5.

Petraites laurentii: Barnard, 1927: 866.

Labroclinus laurentii: Smith, 1945: 544, 1949: 357, pl. 80 fig. 999 and fig. 999.

Description. D. XXIX–XXXIII (XXX–XXXII) 4–5; A. II 20–22 (21–22); P. 12; V. I 3; C. 13. Gill-rakers in outer series on first arch 2–3 + 4–6. Vertebrae 15 + 27–29. First three dorsal spines elevated to form crest. Membrane from third to fourth dorsal spine barely reaches base of fourth. Crest moderate,

second spine highest. Pectoral fin somewhat rounded, but upper edge fairly straight. Inner pelvic ray about half length of other two, very slender. Caudal peduncle moderate, length 33–47% head length, depth 22–33% head length. Caudal fin subtruncate.

Body moderately compressed, covered with small embedded scales extending on to dorsal and caudal fin bases but not anal fin base or head, overlapping on front half of body. Depth 4–5.5 in standard length. Head 4.25–4.75 in standard length, snout rounded to bluntly conical. Eye 2.75–3.75 in head. No supraorbital tentacle. Cirrus on anterior nostril small, flaplike. Upper jaw 36–41% head length. Lips moderately thick. Vomer toothed. Sensory pores of head mostly double, many multiple pores in occipital region (fig. 31(b)).

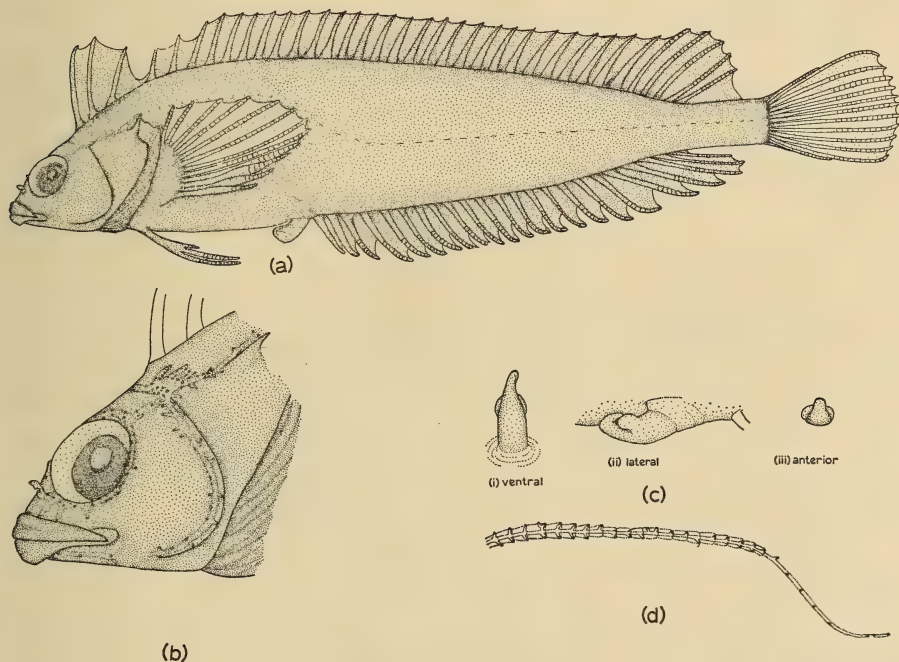


FIG. 31. *Pavoclinus (Pavoclinus) laurentii*: (a) Lateral view, male, 110 mm, Xora, May 1948, R.U.C.; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Lateral line of vertical pairs of pores or single pores opening above or below line in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 31(d)). Intromittent organ of male with short basal portion and large, conical tip, ensheathed at base by pair of confluent dorso-lateral lips (fig. 31(c)).

Colouring. No fresh specimens seen. Smith (1949) described the colouring as 'most variable, but beautiful and delicate colours and markings, brown, red, yellow, green, mottled and marbled.' Uniform buff to yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Female, 108 mm standard length, Winkelspruit, Natal, collected by L. Robinson, donated by R. Robinson, S.A.M. 25234.

Material examined. 15 specimens, 66–117 mm in standard length, 3 from Xora Mouth, R.U.C.; 1 from Bizana Coast, R.U.C.; 1 from Port St. John's, R.U.C.; 1 from Isipingo, R.U.C.; 3 from Winkelspruit, Natal, S.A.M. 25234 (lectotype), S.A.M. 9888 (paralectotypes); 4 from Natal, S.A.M. 10927, S.A.M. 16157, S.A.M. 18515; 1 from Inhaca Island, Mozambique, R.U.C., 1 from Inhambane, Mozambique, R.U.C.

Remarks. *Pavoclinus laurentii* is similar to *Pavoclinus mentalis* in the separation of the dorsal crest and in its distribution, but resembles *Pavoclinus graminis* in body shape, head shape, fin counts, and relative size of eye, and appears to be closer to the more generalized species than to *Pavoclinus mentalis*.

Distribution (fig. 27). Port Alfred (33°36'S., 26°54'E) to Inhambane (23°51'S., 35°29'E) is the known range. The species is said to be not uncommon (Smith, 1949) in weedy pools.

Pavoclinus (Pavoclinus) litorafontis Penrith, 1965
(Fig. 32)

Pavoclinus litorafontis Penrith, 1965a: 212, pl. 5, and figs 1 and 2.

Description. D. XXIX–XXXII (XXXI–XXXII) 7–8; A. II 20–23 (23); P. 11–12; V. I 3; C. 13. Gill-rakers in outer series on first arch 3–4 + 5–6. Vertebrae 17 + 32–33. First three dorsal spines elevated to form crest, decreasing in relative height with increase in size of fish. No notch in membrane between third and fourth dorsal spines. Upper edge of pectoral fin more or less straight. Inner pelvic ray stout, equal to others. Caudal peduncle long, length 58.5–75% head length, depth 22.5–33.5% head length. Caudal fin subtruncate.

Body compressed, covered with small embedded scales extending on to dorsal and caudal fin bases but not anal fin base or head, overlapping over most of body surface. Depth 4.5–5.75 in standard length. Head 3.75–5 in standard length, snout subconical. Eye 3.5–4.25 in head. No supraorbital tentacle. Cirrus on anterior nostril very small. Upper jaw 33.5–41% head length. Lips moderately thick. Vomer toothed. Sensory pores of head mostly single (fig. 32(b)).

Lateral line of single pores in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 32(d)). Intromittent organ of male with short basal portion and large, conical tip; single pair of crescentic dorso-lateral lips ensheathing base of tip (fig. 32(c)).

Colouring. Green, striped in shades of darker green, yellow, and silver longitudinally. Usually a yellow or silver stripe across cheek. Fins green, usually with translucent patches; always translucent patches in the caudal fin. Belly no lighter than ground colour, underparts green. Juveniles green or brown with a broad silver longitudinal stripe mid-laterally. Uniform yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Material examined. 22 specimens, 27–190 mm in standard length. 14 from Strandfontein, False Bay, S.A.M. 23876, S.A.M. 23877, S.A.M. 23952, S.A.M. 23962, S.A.M. 23972, S.A.M. 24052 (holotype), S.A.M. 24248, and March, 1965, S.A.M. not catalogued; 8 from Onrust River Mouth, S.A.M. 24081, S.A.M. 24257.

Remarks. *Pavoclinus litorafontis* appears to be the most strongly modified member of the subgenus *Pavoclinus*, and has the most elongate caudal peduncle in that subgenus. It is closest to *Pavoclinus graminis* in the form of the dorsal fin and the

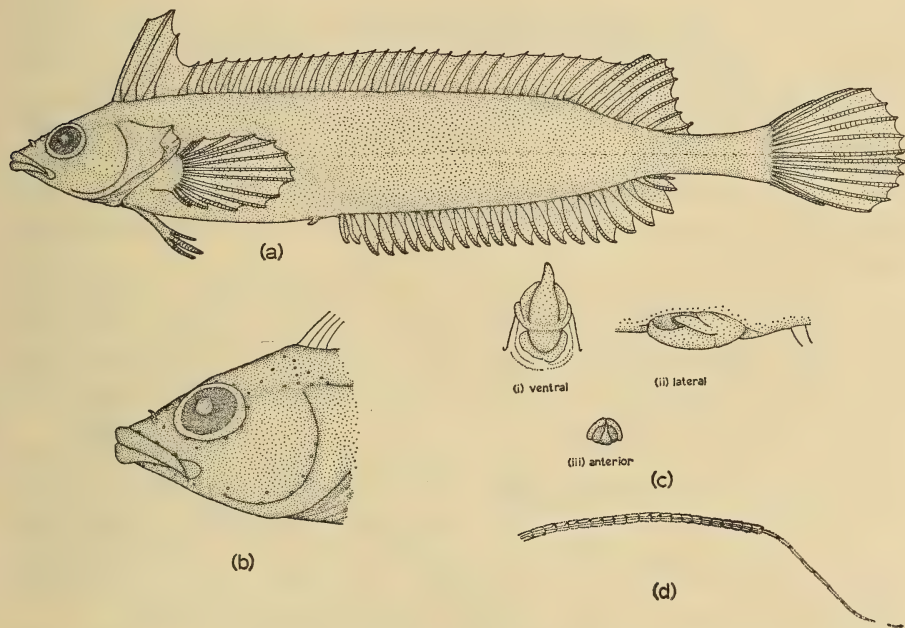


FIG. 32. *Pavoclinus* (*Pavoclinus*) *litorafontis*: (a) Lateral view, male, 89 mm, S.A.M. 23876; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

head. It resembles *Pavoclinus mentalis* in the body proportions but not the fin counts other than the number of soft dorsal rays and the strong development of the inner pelvic ray. It attains a larger size than the other species of the subgenus *Pavoclinus*. Juveniles have a very poorly developed intromittent organ and it is usually impossible to sex small specimens externally.

Distribution (fig. 27). The known range is False Bay ($\pm 34^{\circ}10'S.$, $18^{\circ}50'E$) to Cape Agulhas ($34^{\circ}50'S.$, $20^{\circ}00'E$); not common, in sea-weed low down on the shore, particularly in beds of the green alga *Caulerpa filiformis*.

Pavoclinus (Pavoclinus) pavo (Gilchrist & Thompson, 1908)
(Fig. 33)

Clinus pavo Gilchrist & Thompson, 1908: 123. Barnard, 1927: 857.

Pavoclinus pavo: Smith, 1945: 545, 1949: 357, pl. 81 figs 1000.

Description. D. XXX-XXXVI (XXXI-XXXIII) 2-4 (3); A. II 20-23 (20-22); P. 11-12 (12); V. I 2-3; C. 13. Gill-rakers in outer series on first arch 2-4 + 4-6. Vertebrae 15 + 28-31. First three dorsal spines elevated to form crest, second spine longest. No notch in membrane between third and fourth dorsal spines. Pectoral fin with upper edge more or less straight. Inner pelvic ray minute or absent. Caudal peduncle long, 40-47% head length, depth 20-30% head length. Caudal fin subtruncate.

Body compressed, covered with small embedded scales extending on to base of dorsal fin but not caudal and anal fin bases or head, overlapping on at least front half of body. Depth 3.75-5 in standard length, body deepening with increase in standard length. Head 3.5-4.75 in standard length, snout narrow, acutely pointed. Eye 3-4 in head. No supraorbital tentacle. Cirrus on anterior nostril flattened, flaplike, curving forward over nostril. Upper jaw 22-36.5% head length, mouth small. Lips thick. Vomer toothed. Sensory pores of head mostly single, occipital series and a few of preopercular and suborbital series double (fig. 33(b)).

Lateral line of single pores opening above and below line in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 33(d)). Intromittent organ of male with moderate basal portion and large, conical tip, swollen at base, and surrounded basally by large fleshy pair of ovoid dorso-lateral lips (fig. 33(c)).

Colouring. Variable, green, brown or red, sometimes mottled and striped longitudinally with yellow, lighter shades of the main colour and silvery white. Belly of same shade as ground colour. Often pearly spots on body. Dorsal and caudal fin with translucent patches. A specimen taken from kelp at Hondeklip Bay was olive yellow, with three turquoise blue ocellate spots on side and a turquoise blue line across cheek. Uniform yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Male, 88 mm standard length, St. James/Kalk Bay area, intertidal pools, no other data, S.A.M. 25236.

Material examined. 59 specimens, 15-111 mm in standard length. 1 from Shearwater Bay, Lüderitzbucht, S.A.M. 24213; 2 from Port Nolloth, S.A.M. 24218; 3 from Hondeklip Bay, S.A.M. 25084; 3 from Lambert's Bay, S.A.M. 23250; 1 from Langebaan, S.A.M. 21476; 1 from Melkbosch, 20/10/1964, S.A.M. not catalogued; 1 from Table Bay, S.A.M. 4728; 1 from Miller's Point, False Bay, S.A.M. 23894; 1 from Glencairn, False Bay, S.A.M. 23891; 1 from Kalk Bay, False Bay, S.A.M. 17935; 9 from Dalebrook, False Bay, S.A.M. 23888, S.A.M. 23898, and 18/4/1965, S.A.M. not catalogued; 2 from St. James/Kalk Bay, False Bay, S.A.M. 25236 (lectotype), S.A.M. 10532 (paralectotype); 4 from

St. James, 16/5/1965, S.A.M. not catalogued; 3 from Onrust River Mouth, S.A.M. 24251; 15 from Kidd's Beach, East London, S.A.M. 25085; 4 from Igoda Mouth, East London, S.A.M. 25086; 1 from East London, S.A.M. 23892; 6 from Kei Mouth, S.A.M. 25087.

Remarks. *Pavoclinus pavo* is apparently the only species of the genus *Pavoclinus* occurring on the coast west of Cape Point, although it is much more common east of Cape Agulhas. It is smaller and more delicately built than most of the other species which occur intertidally.

Distribution (fig. 27). The known range is Lüderitzbucht ($26^{\circ}38'S.$, $15^{\circ}10'E$) (South West Africa) to the Kei River ($32^{\circ}41'S.$, $28^{\circ}23'E$). It is nowhere very

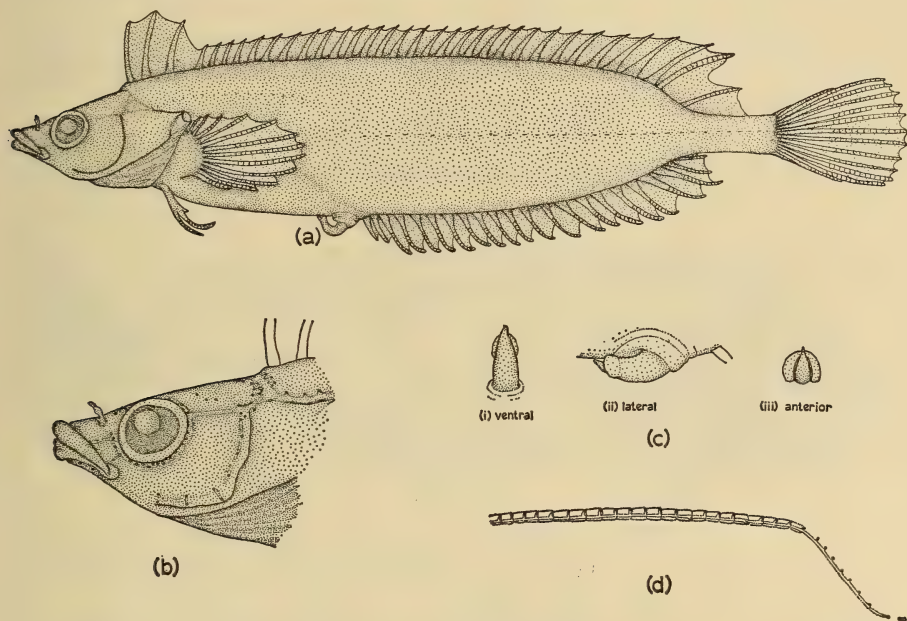


FIG. 33. *Pavoclinus* (*Pavoclinus*) *pavo*: (a) Lateral view, male, 60 mm, S.A.M. 23888; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

common, but is not uncommon towards the eastern limit of its range. It lives intertidally in sea-weed. All the west coast specimens were taken in kelp, but in False Bay and localities eastward most of the specimens were found curled round the bases of short bushy growths of algae such as *Hypnea spicifera*; also in *Caulerpa* beds.

Pavoclinus (*Pavoclinus*) *profundus* Smith, 1960
(Fig. 34)

Pavoclinus profundus Smith, 1960: 689, fig. 1.

Description. D. XXX 4; A. II 21; P. 12; V. I 3; C. 13. Vertebrae 14 + 27. First three dorsal spines not elevated to form crest, but fourth spine slightly

shorter than third or fifth. No notch in membrane between third and fourth dorsal spines. Upper edge of pectoral almost straight. Inner pelvic ray minute, bound to outer rays by membrane, tip not free. Caudal peduncle moderate, length 36.4% head length, depth 27.2% head length. Caudal fin subtruncate.

Body highly compressed, sparsely covered with small embedded scales, not overlapping. Head naked. Depth at anal origin 4.8 in standard length. Head 3.9 in standard length, snout acutely pointed. Eye 3 in head. No supraorbital tentacle. Cirrus on anterior nostril a small flap. Upper jaw 36.4% head length, mouth small. Lips moderately thin. Vomer toothed. Sensory pores of head mostly single (fig. 34(b)).

Lateral line of single pores opening above or below line or medially in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end, becoming obscure on caudal peduncle (fig. 34(d)). Intromittent organ of male with short basal portion and large conical tip; pair of elongate fleshy dorso-lateral lips partially ensheathing tip (fig. 34(c)).

Colouring. Only the preserved type seen. Detailed description of fresh colouring given by Smith (1960). Uniform buff preserved in alcohol.

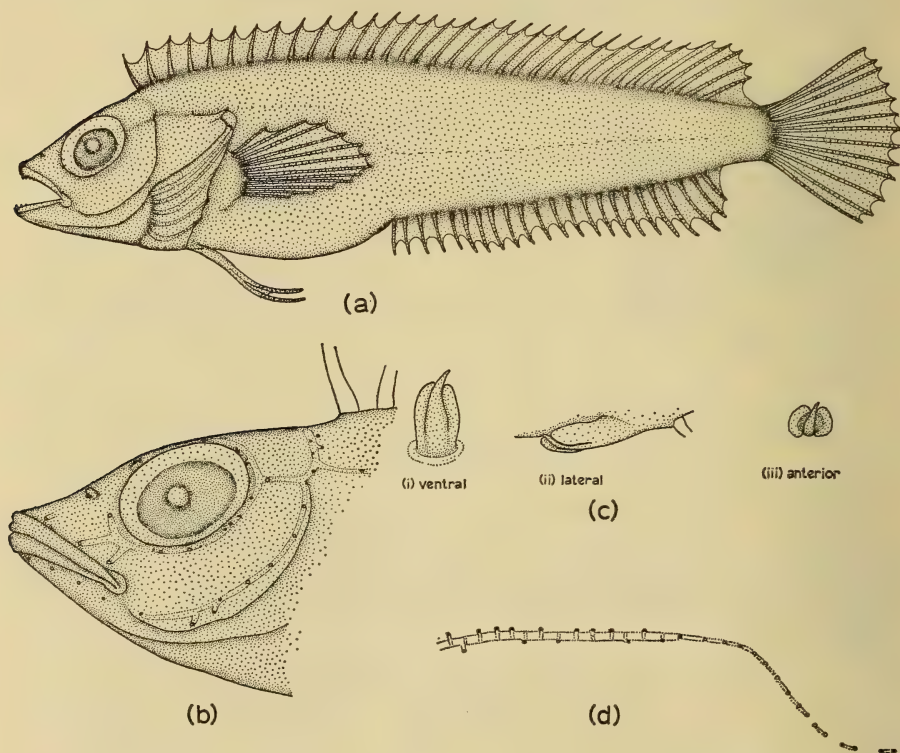


FIG. 34. *Pavoclinus (Pavoclinus) profundus*: (a) Lateral view, male, 43 mm, R.U.C., holotype; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Location of type material. Department of Ichthyology, Rhodes University, Grahamstown.

Material examined. 1 specimen, 43 mm in standard length, Knysna, 20 fms, R.U.C. (holotype).

Remarks. This species is known only from the holotype, and in spite of the lack of a marked dorsal crest it has so many features in common with the other members of the subgenus *Pavoclinus* that it is placed in that subgenus. Not least of these similarities is the form of the intromittent organ. The holotype was stated by Smith (1960) to be a female, but the specimen is clearly a male with an intromittent organ of a type very similar to that of the other species of *Pavoclinus*.

Distribution (fig. 27). Known from one locality, Knysna (34°03'S., 23°03'E); dredged in 20 fathoms from a rocky bank.

Subgenus *Smithichthys* Hubbs, 1952

Myxodes non Cuvier, Smith, 1945: 544 (type-species *Myxodes viridis* Valenciennes in Cuvier & Valenciennes).

Smithichthys Hubbs, 1952: 107 (type-species *Clinus fucorum* Gilchrist & Thompson).

Diagnosis. Vomer edentate; single row of teeth in each jaw. Snout upturned, puglike. First four or five dorsal spines elevated to form high, rounded dorsal crest. Body highly compressed. Scales minute, non-imbricating. Caudal peduncle elongate; caudal rays 13.

One species, *Pavoclinus* (*Smithichthys*) *fucorum* (Gilchrist & Thompson).

Pavoclinus (*Smithichthys*) *fucorum* (Gilchrist & Thompson, 1908)

(Fig. 35)

Clinus fucorum Gilchrist & Thompson, 1908: 121. Barnard, 1927: 853.

Myxodes fucorum: Smith, 1945: 544, 1949: 356, pl. 81 fig. 996.

Smithichthys fucorum: Hubbs, 1952: 107. Smith, 1953: 356, pl. 81 fig. 996.

Description D. XXVIII-XXXI (XXIX-XXX) 4-6 (5-6); A. II 19-21; P. 12-13 (12); V. I 3; C. 13. Vertebrae 15 + 28-29. First dorsal spine originates well forward, over hind margin of eye. First four or five dorsal spines elevated to form high rounded crest. No notch in dorsal fin membrane between any of the spines; all spines evenly placed. Dorsal spines of varying lengths, giving outline of fin markedly undulating appearance. Pectoral fin more or less rounded, upper edge somewhat straight. Inner pelvic ray stout, almost equal to others. Caudal peduncle long, length 47-62.5% head length, depth 23.5-30% head length. Caudal fin subtruncate, very large.

Body highly compressed, deep, covered with small embedded scales not extending on to fin bases or head, not overlapping. Depth 3.5-4 in standard length. Head 4-4.75 in standard length, snout rounded, upturned, puglike. Eye 3-5 in head. No supraorbital tentacle. Cirrus on anterior nostril short, with expanded trilobate tip. Upper jaw 32-42% head length. Lips fairly

thick. Vomer edentate; single row of teeth in each jaw. Sensory pores of head mostly single, a few double in supraorbital and suborbital series (fig. 35(b)).

Lateral line of single pores opening more or less medially in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 35(d)). Intromittent organ of male with moderate basal portion and long, conical tip, ensheathed basally by wing-like pair of dorso-lateral lips (fig. 35(c)).

Colouring. Uniform dark brown or olive, edges of fins lighter or transparent; two irregular translucent patches in caudal fin. A bright silvery iridescent spot behind pectoral fin. Uniform yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Male, 160 mm standard length, St. James, no other data, S.A.M. 25235.

Material examined. 13 specimens, 42–196 mm in standard length. 9 from St. James, False Bay, S.A.M. 25235 (lectotype), S.A.M. 10524 (paralectotypes),

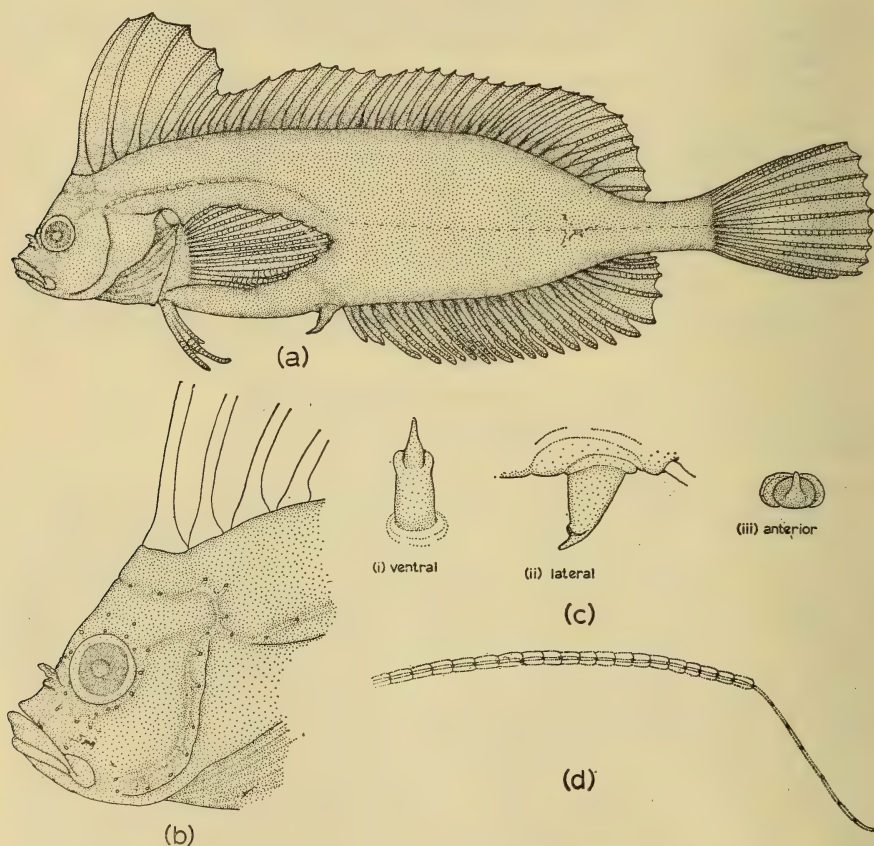


FIG. 35. *Pavoclinus* (*Smithichthys*) *fucorum*: (a) Lateral view, male, 101 mm, St. James, 16/5/1965, S.A.M.; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

S.A.M. 12020, and 16/5/1965, S.A.M. not catalogued; 2 from Muizenberg, False Bay, S.A.M. 10525; 2 from Strandfontein, False Bay, S.A.M. 23886 and March, 1965, S.A.M. not catalogued.

Remarks. *Pavoclinus fucorum* is a peculiar, rare, highly specialised weed-dwelling species. It resembles *Pavoclinus mus* in lacking vomerine teeth, but otherwise differs from it in as many ways as it does from the members of the other subgenera of *Pavoclinus*.

Distribution (fig. 27). The known range is False Bay ($\pm 34^{\circ}10'S$, $18^{\circ}50'E$) to the Bashee River ($31^{\circ}55'S$, $28^{\circ}27'E$); rare, in sea-weed. At the bottom of the intertidal region and infratidal.

Genus BLENNIOCLINUS Gill, 1860

Blennioclinus Gill, 1860: 103 (type-species *Clinus brachycephalus* Valenciennes in Cuvier & Valenciennes, by monotypy).

Diagnosis: No supraorbital tentacle. Last dorsal spine about half length of first dorsal ray, deep notch in profile of dorsal fin before dorsal soft rays. Lateral line of double pores anteriorly to post-pectoral curve, then of short separate hori-

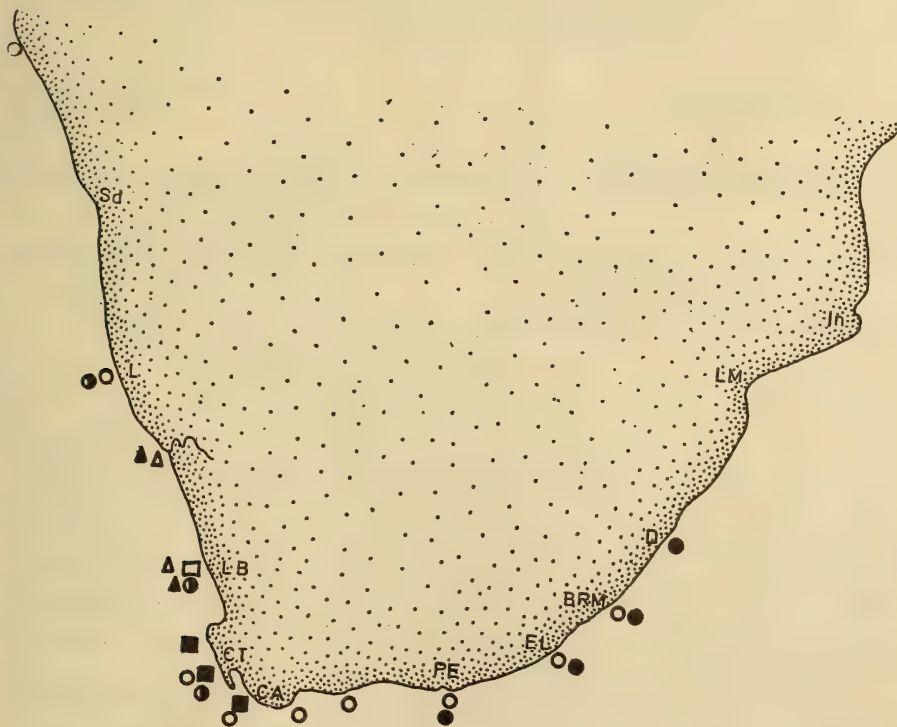


FIG. 36. Distribution of *B. brachycephalus* (open circles), *B. stella* (closed circles), *Clinoporus biporosus* (closed squares), *G. rotundifrons* (half-closed circles), *Cancelloxus burrelli* (open triangles), *X. leprosus* (closed triangles), *X. kochi* (open squares).

zontal tubes with pore at either end. Intromittent organ of male with short or moderate basal portion and long slender tip concealed between pair of very large lateral lips. Body covered with small embedded cycloid scales, not extending on to fin bases or head. First three dorsal spines elevated to form low crest. Notch in membrane between third and fourth dorsal spines. Clusters of cirri at tips of at least anterior dorsal spines. Vomer toothed. Head short, profile rounded.

Two species.

Discussion. The genus *Blennioclinus* was included by Smith (1945) in his Myxodinae on account of the lack of a supraorbital tentacle. However, the two species *brachycephalus* and *stella* are not weed-dwellers and are further set apart from the genus *Pavoclinus* by the notch in the profile of the dorsal fin before the dorsal soft rays, the clusters of cirri at the tips of the dorsal spines, the body form, the type of intromittent organ, and the high number of double pores in the anterior part of the lateral line. They differ from the genus *Clinus* mainly in having a notch before the dorsal soft rays, and in lacking a supraorbital tentacle. I therefore regard the genus *Blennioclinus* as distinct from the other clinid genera.

Distribution. West and east coasts of South Africa (fig. 36).

Key to the species of Blennioclinus

- | | | | | | | |
|--------------------------|----|----|----|----|----|-------------------------------------|
| 1. 8-11 dorsal soft rays | .. | .. | .. | .. | .. | <i>Blennioclinus brachycephalus</i> |
| 6-7 dorsal soft rays | .. | .. | .. | .. | .. | <i>Blennioclinus stella</i> |

Blennioclinus brachycephalus (Valenciennes in Cuvier & Valenciennes, 1836)
(Fig. 37)

Clinus brachycephalus Valenciennes in Cuvier & Valenciennes, 1836: 371. Gilchrist & Thompson, 1908: 135. Barnard, 1927: 852.

Labrisomus linearis Swainson, 1839: 277.

Blennioclinus brachycephalus: Gill, 1860: 103. Smith, 1945: 543, 1949: 356; pl. 79 fig. 995.

Description. D. XXVI-XXX (XXVIII-XXIX) 8-11 (9-11); A. II 19-25 (21-24); P. 12-15 (13-14); V. I 3; C. 13. Gill-rakers in outer series on first arch 2-3 + 3-5. Vertebrae 17 + 28-30. First three dorsal spines slightly elevated, first spine 0-2 mm longer than fourth, crest very low. Third and fourth dorsal spines more widely spaced than others, very shallow notch in membrane between them. Dorsal spines decrease in height posteriorly, last spine very short, dorsal soft rays much higher; deep notch in profile of dorsal fin before dorsal soft rays. Clusters of 3-4 cirri at tips of most dorsal spines. Pectoral fin rounded. Inner pelvic ray short, slender. Caudal peduncle moderate, 35-40% head length, depth 23-31% head length. Caudal fin subtruncate.

Body slightly compressed, covered with minute embedded scales not extending on to dorsal, caudal, or anal fin bases or head. Depth 5-5.75 in standard length. Head short, bluntly rounded, 4-5 in standard length. Eye 2.5-3.5 in head. No supraorbital tentacle. Cirrus on anterior nostril flattened,

irregularly trilobed. Upper jaw 28.5–34% head length, mouth small. Lips thin. Vomer toothed. Sensory pores of head mostly double, with multiple pores mainly in occipital series (fig. 37(b)).

Lateral line of about 30–35 multiple pores in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 37(d)). Intromittent organ of male with moderate basal portion and slender tip ensheathed by large pair of lobed dorso-lateral lips (fig. 37(c)).

Colouring. Ground colour creamy fawn, much overlain with dark brown blotches and reticulations, denser dorsally. Belly creamy or bright yellow, with dark band running from isthmus towards vent, having broad dark symmetrical vertical branches running up to the densely mottled area above. Sometimes

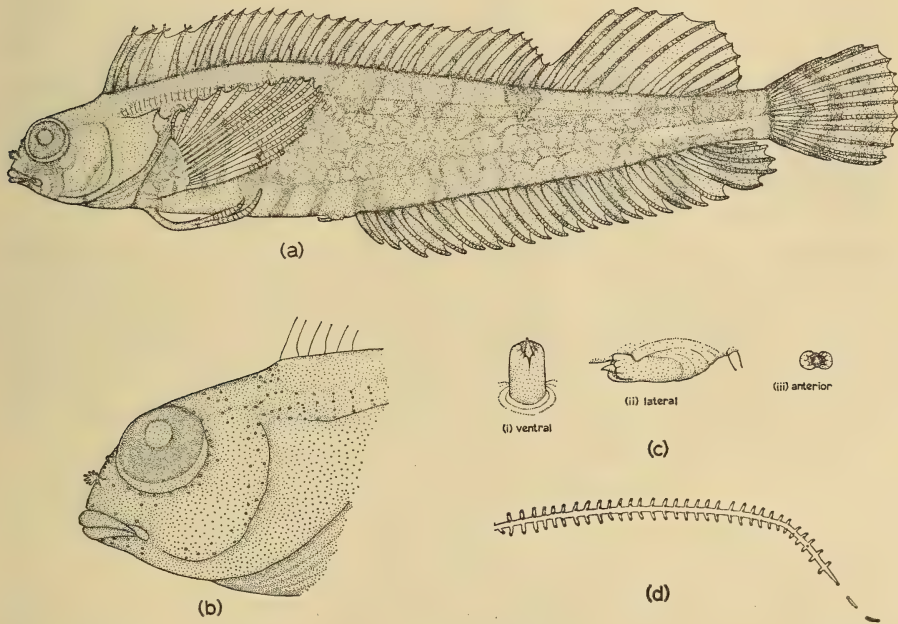


FIG. 37. *Blennioclina brachycephalus*: (a) Lateral view, male, 73 mm, S.A.M. 23974; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

fine orange stripes alternate with dark bands. A red-edged bright blue semi-circular spot behind pectoral fin. Head dark above to lighter brown below. Two mauve wavy lines on preopercle and opercle. Dark irregular band from below eye to angle of jaw. Spinous dorsal dark brown, with red tips to spines. Dorsal soft rays dark brown, membrane joining them cream barred with brown between first five rays, then plain cream. Anal fin with broad brown cross-bars, ground colour creamy, tips of rays red. Pectoral fin cream with dark brown cross-bars. Pelvic fins dark at base, then cream with two narrow red bars distally. Caudal fin cream with irregular dark brown markings. Branchiostegal

membranes mauve, with dark brown cross-bars. Juveniles plain dark red with longitudinal row of large silvery spots along side. Pattern remains defined for some time after preservation, slowly fading to yellow-buff.

Location of type material. Muséum National d'Histoire Naturelle, Paris.

Material examined. 223 specimens, 17–100 mm in standard length. 1 from Cape, Paris Museum Cat. No. A2013 (holotype); 12 from Lüderitzbucht, S.A.M. 24210; 2 from Simon's Bay, False Bay, S.A.M. 10534; 13 from Dalebrook, False Bay, 18/12/1964, 19/2/1965, 18/4/1965 and 16/5/1965, S.A.M. not catalogued; 2 from St. James, False Bay, S.A.M. 12014; 146 from Strandfontein, False Bay, S.A.M. 23875, S.A.M. 23953, S.A.M. 23970, S.A.M. 23974 and 20/11/1964 and 13/8/1964, S.A.M. not catalogued; 1 from Gordon's Bay, False Bay, S.A.M. 23293; 1 from Die Dam, Bredasdorp district, S.A.M. 25088; 25 from Still Bay, S.A.M. 18265, S.A.M. 25089; 1 from Port Elizabeth, S.A.M. 24244; 2 from East London, S.A.M. 18092; 2 from Kei Mouth, S.A.M. 25090.

Remarks. *Blennioclinus brachycephalus* is the more widely distributed and common of the two species of *Blennioclinus*. It is also the larger. The notched profile of the dorsal fin is interesting, since the same condition is found in some of the American Labrisominae, e.g. *Labrisomus* and *Malacoctenus*, but not in any of the other Clininae.

Distribution (fig. 36). Lüderitzbucht (26°38'S., 15°10'E) (South West Africa) to the Kei River (32°41'S., 28°23'E); locally common east of Cape Point, in pools at the low tide mark, usually among pebbles and sea-urchins. The species has not been found at any localities on the west coast between Melkbosch (west coast of Cape Peninsula) and Lüderitzbucht (Penrith, 1965b). The Lüderitzbucht specimens were all collected in sheltered areas, not on the open coast. They are in no way different from the south coast populations.

Blennioclinus stella Smith, 1945

(Fig. 38)

Blennioclinus stella Smith, 1945: 543, fig. 4, 1949: 386, pl. 79 fig. 994.

Description. D. XXIV–XXVIII 6–7; A II 19–21; P. 12; V. I 3; C. 13. Gill-rakers in outer series on first arch 1–2 + 4–6. Vertebrae 13 + 25–27. First three dorsal spines elevated to form low crest. Gap between third and fourth spines wider than between other spines; deep notch in membrane between third and fourth spines. Dorsal spines decrease in height posteriorly, last spine very short, dorsal soft rays much longer, resulting in deep notch in profile of dorsal fin before dorsal soft rays. Clusters of cirri at tips of first three dorsal spines. Pectoral fin rounded. Inner pelvic ray minute. Caudal peduncle short, length 27.5–33% head length, depth 27.5–33.5% head length. Caudal fin subtruncate.

Body slightly compressed, covered with small embedded scales not extending on to dorsal, caudal, or anal fin bases or head. Depth 5.25–5.75 in standard length. Head 3.75–5.25 in standard length, snout rounded. Eye 2.5–3.25 in

head. No supraorbital tentacle. Cirrus on anterior nostril elongate, narrow proximally, with tip expanded and deeply serrate. Upper jaw 37.5–47.5% head length. Lips moderately thick. Vomer toothed. Sensory pores of head mostly double, single in nasal, interorbital and in most of preopercular series (fig. 38(b)).

Lateral line of 20–25 vertical pairs of pores in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end (fig. 38(d)). Intromittent organ of male with slender tip ensheathed by pair of large, flat ventro-lateral lips, with slightly serrate margins (fig. 38(c)).

Colouring. No live or unpreserved specimens seen. Smith (1945) described the colouring as 'variably brown, red and orange mottled. Three narrow bars

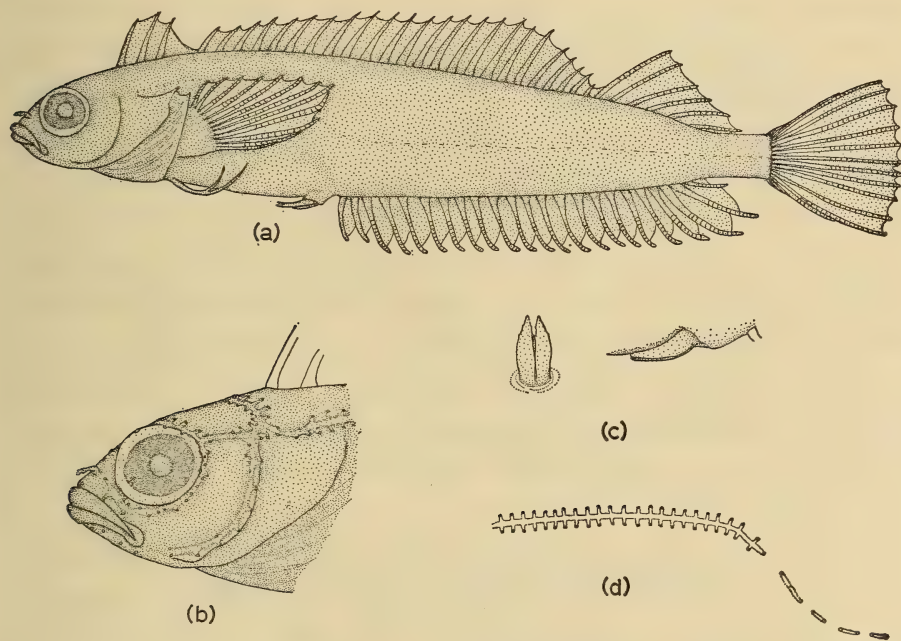


FIG. 38. *Blennioclinus stella*: (a) Lateral view, male, 39.5 mm, Xora, August 1947, R.U.C.; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

across head, one through eye to cheek. Eight to ten cross-bars on body, spreading to dorsal fin. Sometimes iridescent silvery patches along flanks.' Two very small freshly preserved juvenile specimens examined were yellowish red, mottled and barred. Uniform yellow preserved in alcohol.

Location of type material. Department of Ichthyology, Rhodes University, Grahamstown.

Material examined. 7 specimens, 26–38 mm in standard length. 2 from Port Elizabeth, S.A.M. 24245; 3 from Cape Morgan, R.U.C.; 2 from Xora Mouth, August 1947, R.U.C.

Remarks. *Blennioclinus stella* is the smallest of the South African Clinidae. It is very similar to *Blennioclinus brachycephalus*, but can be distinguished from it by the lower number of dorsal soft rays.

Distribution (fig. 36). Port Elizabeth ($33^{\circ}58'S.$, $25^{\circ}36'E$) to Durban ($29^{\circ}53'S.$, $31^{\circ}00'E$); not common in southern part of range at least; usually in shallow pools at the bottom of the shore, among sand and pebbles (Professor J. L. B. Smith, personal communication).

Genus CLINOPORUS Barnard, 1927

Clinoporus Barnard, 1927: 864 (type-species *Clinus biporosus* Gilchrist & Thompson, by monotypy).

Diagnosis: Body and head without scales, elongate, robust. No supraorbital tentacle. Dorsal fin low, even, anterior spines not raised to form crest. Lateral line of large pores opening above and below line throughout, very broad and conspicuous. Pores on head large. Vomer toothed.

One species, *Clinoporus biporosus* (Gilchrist & Thompson).

Discussion. *Clinoporus* is a peculiar genus whose only known representative is infra- rather than intertidal. The lateral line is very distinctive and unlike that of any other clinid. The lack of scales is unique in the Clininae. C. L. Smith (1957) investigated the possibility of the degree of scaling of clinids being related to the amount of water movement in the environment of the adult, but concluded that the two factors are not correlated.

The inclusion of *Clinoporus biporosus* in the 'Myxodinae' by Smith (1945), together with *Pavoclinus*, *Blennioclinus* and *Gynutoclinus*, solely on the basis of the lack of a supraorbital tentacle is unjustifiable, since this species bears no resemblance to either the weed-dwellers of the genera *Pavoclinus* and *Gynutoclinus* or to the species of *Blennioclinus*.

Clinoporus biporosus (Gilchrist & Thompson, 1908)

(Fig. 39)

Clinus biporosus Gilchrist & Thompson, 1908: 137.

Clinoporus biporosus: Barnard, 1927: 864. Smith, 1945: 545, 1949: 358, pl. 82 fig. 1003.

Description. D. XXXVIII-XLI 3; A. II 27-28; P. 12-13; V. I 3; C. 13. Vertebrae 17 + 32-35. Dorsal fin low, even, no notch in membrane between third and fourth dorsal spines. No clusters of cirri at tips of dorsal spines. Pectoral fin rounded. Inner pelvic ray minute. Caudal peduncle short, length 23-26% head length, depth 28.5-31% head length. Caudal fin subtruncate.

Body robust, elongate, naked. Depth 6.25-6.85 in standard length. Head 4.5-6.25 in standard length, snout rounded. Sensory pores large and conspicuous, mostly single (fig. 39(a)). Eye 2.75-4.25 in head. No supraorbital tentacle. Cirrus on anterior nostril small, flaplike. Upper jaw 34-43% head length. Lips moderately thick. Vomer toothed.

Lateral line throughout of large pores opening above and below line, close together and numerous; line broad; ends in single pore on caudal peduncle (fig. 39(a)). Intromittent organ of male with moderate basal portion and small tip protruding between two rounded ventral lips (fig. 39(b)).

Colouring. No fresh specimens seen; uniform red, brown or orange (Smith, 1949). Uniform buff preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Lectotype. Female, 117 mm, St. James, S.A.M. 25241.

Material examined. 7 specimens, 46–116 mm in standard length. 3 from Saldanha Bay, S.A.M. 18463; 2 from St. James, False Bay, S.A.M. 25241 (lectotype),

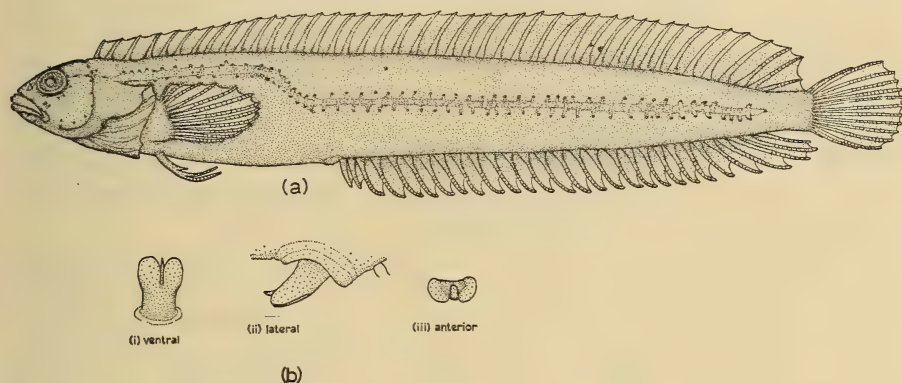


FIG. 39. *Clinoporus biporosus*: (a) Lateral view, female, 117 mm, S.A.M. 25241, lectotype; (b) Intromittent organ of male.

S.A.M. 10529 (paralectotype), 1 from False Bay, 14 fathoms, S.A.M. 10528 (paralectotype); 1 from False Bay, dredged, S.A.M. 23949.

Distribution. Saldanha Bay (33°00'S., 17°56'E) to False Bay ($\pm 34^{\circ}10'S.$, 18°50'E) is the known range. Rare, mainly infratidal.

Genus GYNUTOCLINUS Smith, 1945

Gynutoclinus Smith, 1945: 545 (type-species *Clinus rotundifrons* Barnard, by monotypy).

Diagnosis: A minute simple papilla over eye. Body highly compressed. Head spherical, inflated, with pores opening on prominent papillae. Body covered with minute, embedded, cycloid scales, which do not extend on to median fin bases or head. Lateral line of single, more or less medially opening pores in front to post-pectoral curve, then of short separate horizontal tubes with pore at either end, becoming obscure caudally. Intromittent organ of male with long basal portion; tip ensheathed by two pairs of lips. Vomer toothed.

A single, rare species, *Gynutoclinus rotundifrons* Barnard.

Gynutoclinus rotundifrons (Barnard, 1937)
(Fig. 40)

Clinus rotundifrons Barnard, 1937: 63, fig. 4.

Gynutoclinus rotundifrons: Smith, 1945: 545, 1949: 358, fig. 1002. Penrith, 1965a: 215, figs 3, 4.

Description. D. XXX-XXXII 8; A II 22-23; P. 12-14; V. I 3; C. 13. Vertebrae 16 + 28-29. First four dorsal spines slightly elevated to form low, rounded crest, second and third spines highest. All spines evenly placed. No clusters of cirri at tips of dorsal spines. No notches in membrane between any of the dorsal spines. Profile of dorsal fin undulating. Pectoral fin rounded. Inner pelvic ray reduced, not more than half other two rays. Caudal peduncle short, length 28.6-36.4% head length, depth 27.5-32% head length. Caudal fin subtruncate.

Body highly compressed, deepening with age, covered with small scales not extending on to bases of dorsal, caudal, or anal fins, or head. Depth 3.5-5.2 in standard length. Head 3.7-4.15 in standard length, spherical, inflated, broad, with pores opening on raised papillae. Eye 3.5-5 in head. Minute simple papilla over eye. Anterior nostril tubular, cirrus large, flat, deeply bilobed. Posterior nostril conspicuous, surrounded by short skinny lobes. Upper jaw 42.5-54.5% of head length. Lips very thin. Vomer toothed. Sensory pores of head mostly double (fig. 40(b)), opening on raised papillae.

Lateral line of single, more or less medially opening pores in front to post-pectoral curve, then of short, separate horizontal tubes with pore at either end (fig. 40(d)), obsolete on caudal peduncle on largest specimen, the holotype. Intromittent organ of male with long basal portion and a clubshaped tip, ensheathed by pair of thin, crescentic lateral lips and minute pair of more or less confluent dorsal lips (fig. 40(c)).

Colouring. Male from Lambert's Bay: ground colour pale brown with about seven darker brown irregular cross-bars, edged with iridescent blue fine broken lines. A very dark brown, narrow, vertical line behind and above the pectoral axil, and another at end of caudal peduncle. Cross-bars continued on to dorsal fin, with translucent patches between; small black dots on translucent areas. Dorsal fin dark brown posteriorly, with single small translucent patch near beginning of dorsal soft rays at base. Caudal fin translucent, with very faint brown cross-bars, darkening at margins so that margins appear to be spotted. Pectoral fin translucent with four very fine dark cross-bars, proximal one curved. Anal fin mainly dark brown, with two translucent patches. Head mainly light brown below. Dark stripe from below eye forwards in front of inflated cheek to angle of jaw. Head above and opercular region deep pink. Snout pink with darker pink bar between eyes and another above upper lip; fine darker pink line down middle. Eye silvery with brown radii. Chin and lips light brown mottled heavily with darker brown. Branchiostegal membranes and jugular region silvery grey with fine black speckling. Pelvic fins light brown with dark brown cross-bars. Belly silvery with golden brown sheen. Intromittent organ greyish with fine black speckling. Juvenile from Lambert's Bay yellow, under-

parts lighter. Dorsal fin with alternating pink and translucent patches. Anal fin yellow. Caudal and pectoral fins translucent. Pelvic fins yellow with brown cross-bars. Uniform pinkish to yellow preserved in alcohol.

Location of type material. South African Museum, Cape Town.

Material examined. 8 specimens, 26–95 mm in standard length. 1 from Lüderitzbucht, S.A.M. 25091; 2 from Lambert's Bay, S.A.M. 24007, S.A.M. 24082; 4 from Lambert's Bay, R.U.C.; 1 from Oudekraal, Cape Peninsula, S.A.M. 18587 (holotype).

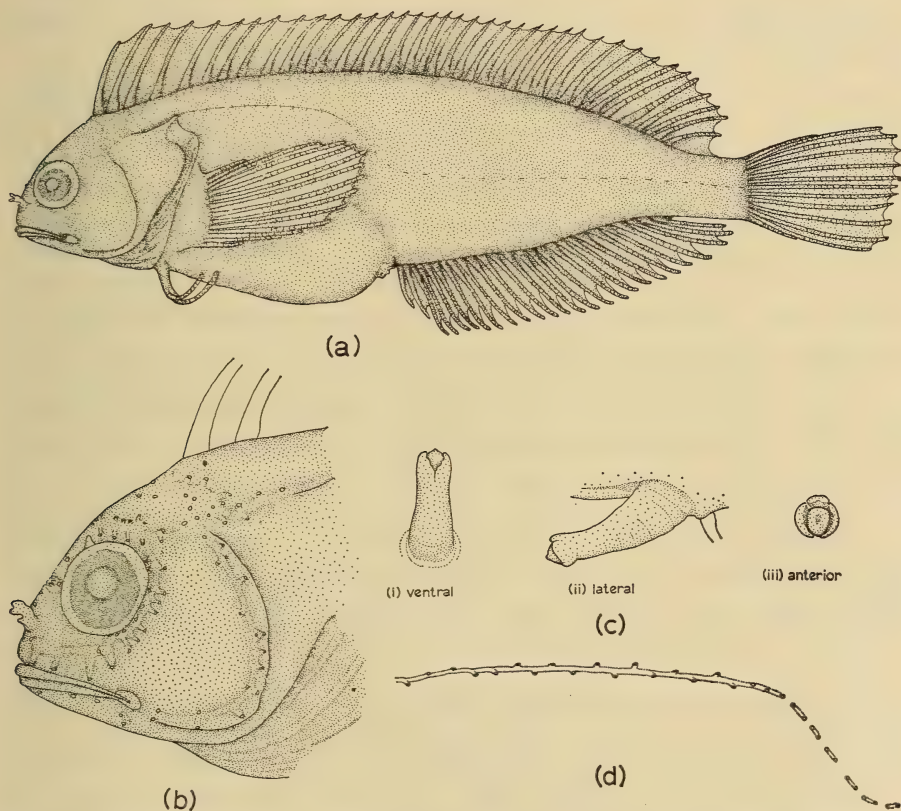


FIG. 40. *Gynutoclinus rotundifrons*: (a) Lateral view, female, 85 mm, S.A.M. 18587, holotype; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Remarks. This very rare species does not appear to be very close to any of the other species, although it has certain modifications for a weed-dwelling habit such as the strong compression of the body. It is known from eight specimens, four in the South African Museum, and four in the Rhodes University Ichthyology Department, the latter taken from the stomachs of sea-birds at Lambert's Bay and therefore in rather poor condition. The species was included by Smith

(1945) in the 'Myxodinae', but in fact it has a small supraorbital tentacle, although this is not very distinct in the long-preserved holotype. The tentacle is quite prominent in fresh specimens. The intromittent organ of this species is very similar to the type found in the genus *Clinus*.

Distribution (fig. 27). The known range is Lüderitzbucht ($26^{\circ}38'S$, $15^{\circ}10'S$) to Cape Point ($34^{\circ}21'S$, $18^{\circ}29'E$); in kelp at the bottom of the shore. Apparently very rare.

Subtribe XENOPOCLINIDI Hubbs, 1952

Diagnosis: Clinini with hook on pectoral girdle sometimes reduced or absent. Head depressed; eyes dorsal. Pelvic fins of three slender, equal rays, united from base to tips by membrane. Dorsal fin low, even.

Discussion. Smith (1947b) described a new genus and species of clinid, *Xenopoclinus kochi*, from a rock-pool at Lambert's Bay on the south-western Cape coast approximately 200 miles north of Cape Town. He placed this species in the family Clinidae, but distinguished it by creating for it a separate 'subfamily' (equivalent to a subtribe in Hubbs' 1952 classification). Subsequently another genus and two more species, *Xenopoclinus leprosus* and *Cancelloxus burrelli*, obviously closely related to *Xenopoclinus kochi*, were described from the Lambert's Bay area by Smith (1961). Smith then separated the three species from the Clinidae and created for them a new family, Xenopoclinidae.

The three species are all adapted to a sand-burrowing existence. The body is elongate, and the head is depressed, with the eyes in a dorsal, anterior position. The pectoral fins are pointed, the middle rays being longer, and are used in sweeping back the sand when burrowing. The jugular pelvic fins consist of a minute spine and three rays of about equal length joined by a membrane that extends well up between them, having the appearance of an amphibian webbed foot. In *Xenopoclinus kochi*, but not in the other species, the opercular membranes are expanded and overlap below. The opercular membranes of *Cancelloxus burrelli* are expanded slightly above to form a fold over the pectoral axil.

In other respects they are much like the South African Clinidae. The scales are minute, embedded, and cycloid. The jaw teeth are conical and fixed, with usually a row of villiform teeth behind, at least at the jaw symphyses. The two species of *Xenopoclinus* have teeth on the vomer, but in *Cancelloxus* the vomer is edentate. There are no palatine teeth. The lateral line canals on the head are covered; the lateral line itself is variable. In *Xenopoclinus kochi* the lateral line follows a similar course to that of the Clinidae but is interrupted behind the level of the pectoral fin, so that the anterior, dorsal portion is separate from the posterior, mid-lateral portion. In *Xenopoclinus leprosus* the lateral line is similar to that of the Clinidae, with no interruptions. In *Cancelloxus burrelli* the lateral line is continuous, but curves down very much more gently than in the other species to a mid-lateral position.

The dorsal fin is low and continuous, the anterior spines being the shortest, and there are many more spinous than soft elements. There are two anal spines.

All the soft fin rays are unbranched. The gill membranes are united, forming a fold across the throat. There are six branchiostegal rays on either side. *Xenopoclinus kochi* has an upturned, hook-like process on the anterior border of the pectoral girdle, but the other species show reduction or absence of this feature. The young are born alive, and the male has a fleshy penis for the transmission of sperm.

The question arises as to whether these three species, which have so much in common with the South African Clinidae, should be placed in a separate family.

Smith (1961) differentiated the Xenopoclinidae from the Clinidae by the following characters: (i) the peculiar head, (ii) the expanded opercular membrane, (iii) the form of the pelvic fins, and (iv) the greater relative length of the anal fin.

The form of the head and pelvic fins are associated with the sand-burrowing habit of these fishes. The expanded opercular membranes occur only in one of the three species, so cannot be considered as a strong differentiating character. The species which shows this feature burrows in finer sand than the other two species, and may have developed the expanded opercular membranes as a result of this.

The meaning of the greater 'relative' length of the anal fin is not entirely clear. The length of the anal fin base, about 60% standard length, is somewhat greater in the Xenopoclinidi than in the South African Clinidi, about 40-50%. This 10% difference seems hardly great enough to warrant separation at the family level, in view of the considerable similarities between the two groups. However, it is probable that by 'relative' length of the anal fin Smith (1961) meant the number of anal elements relative to the degree of elongation of the body as reflected by body depth in standard length. If this is the case, then the anal fin is not relatively longer in the Xenopoclinidi than in the elongate species of South African Clinidi. *Xenopoclinus kochi* and *X. leprosus*, with a body depth of 6-8, have 29-30 and 28-34 anal rays respectively; *Clinus capensis*, with a body depth of 5-6, has 26-34 anal rays, *C. dorsalis*, body depth 5.5-7, has 25-31; and *C. anguillaris*, the most elongate of the South African Clinidi, with a body depth of 6-8, has 33-37 anal rays. *Cancellotus burrelli* has a greater number of anal rays (38-43) than any of the South African Clinidi, but the body depth is 8-11, greatly elongated in comparison with the other species. If only the number of anal rays is considered, with no regard for the elongation of the body, then *Cancellotus burrelli* certainly has a longer anal fin than any of the South African Clinidi, but the anal counts of *Xenopoclinus kochi* and *X. leprosus* fall well within the ranges found among the South African Clinidi.

It seems, then, that the differences between the South African Clinidi and the Xenopoclinidi are those concerned with the adaptation of the Xenopoclinidi to a burrowing existence; the depressed head with dorsally placed eyes, the modified pelvic and pectoral fins, and the expansion of the opercular membranes of *Xenopoclinus kochi*.

Owing to the large number of features which the Xenopoclinidi share with the Clinidi, particularly with the South African species, it is felt that separation at the family level is unjustified, since it serves only to obscure the obvious similarity of the two groups of species. That the Xenopoclinidi were derived from the South African Clinidi, or at least from a common ancestor which had already developed internal fertilization and a penis in the male, seems very probable in view of the similarities of the two groups, particularly with regard to the reproductive organs. Although the hook on the pectoral girdle, so characteristic of the Clininae, is apparently in the process of being lost in the Xenopoclinidi, it is invariably present in *Xenopoclinus kochi*, and traces of it are present in the other species. Sixteen specimens of *Cancelloxus burrelli*, including the

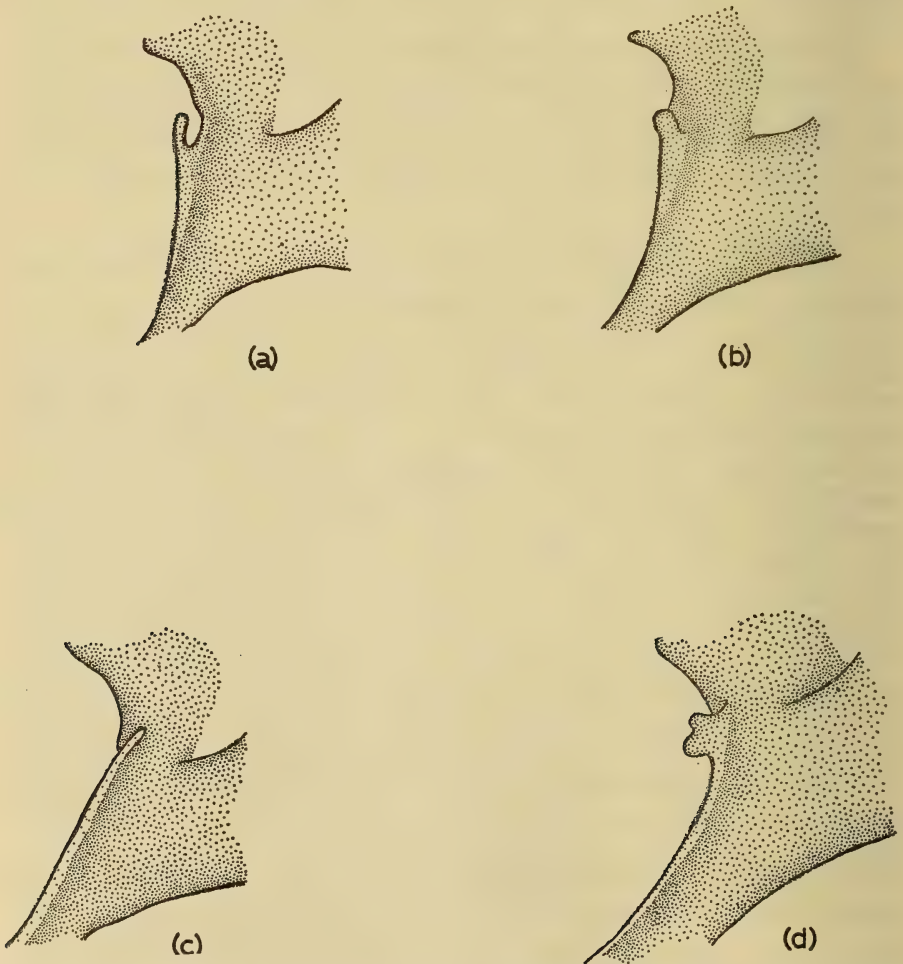


FIG. 41. Anterior border of cleithrum of: (a) *Clinus superciliosus*; (b) *Xenopoclinus kochi* (c) *Xenopoclinus leprosus*; (d) *Cancelloxus burrelli*.

holotype, were examined, all of which had a projecting bony lamina on the anterior border of the pectoral girdle. Of a sample of 89 specimens of *Xenopoclinus leprosus* examined, 32 had a small knob-like process on the anterior border of the pectoral girdle. This feature is illustrated in figure 41.

Hubbs (1952) gave Smith's (1949) subfamily Xenopoclininae the status of a subtribe of the Clinini. He named the subtribe 'Xenopoclinini'. It is proposed here that this arrangement should be adopted, and that the three species *Xenopoclinus kochi*, *X. leprosus* and *Cancelloxus burrelli* be placed in the subtribe Xenopoclinidi.

The resemblance the Xenopoclinidi bear to the American sand-burrowing family known as the Dactyloscopidae is at first sight startling. The head, pectoral fins, and particularly the pelvic fins are strikingly similar in the two groups. Smith (1961) noted this resemblance, but pointed out that they differ in that the Xenopoclinidi have vomerine teeth (two of the three species), many more dorsal spines than dorsal soft rays, small, embedded, non-imbricate scales, united gill membranes forming a fold across the throat, and at least some vestige of a hook on the pectoral girdle; on the other hand, they lack skinny fringes on the opercle and lips, which are characteristic of the Dactyloscopidae. The Xenopoclinidi differ further from the Dactyloscopidae in having a generally more elongate body, unbranched caudal rays, the uppermost pectoral ray articulating with a pectoral radial (it articulates with the scapula in the Dactyloscopidae, Dr. V. G. Springer, personal communication), the ectopterygoid and mesopterygoid distinct (these two bones are fused in the Dactyloscopidae, Dr. V. G. Springer, personal communication), and a fleshy penis in the male.

Key to the genera of the Xenopoclinidi

1. Vomer toothed. Lateral line curves down sharply behind pectoral fin, may be discontinuous over curve. A simple papilla or flap above the eye *Xenopoclinus*
 Vomer edentate. Lateral line curves down very gently from front to median position. No
 papilla or flap above the eye *Cancelloxus*

Genus XENOPOCLINUS Smith, 1947

Xenopoclinus Smith, 1947b: 732 (type-species *Xenopoclinus kochi* Smith, by monotypy).

Xenopoclinops Smith, 1961: 354.

Diagnosis. A disc-like, fleshy papilla or simple flap over eye. Body elongate, compressed, covered with minute embedded cycloid scales not extending on to median fin bases or head. Vomer toothed. Lateral line curves down sharply to medial position behind pectoral fin, discontinuous over curve.

Discussion. Smith (1961) divided this genus into two subgenera on the basis of the presence or absence of a hook on the pectoral girdle, and whether or not the opercular membranes were expanded and overlapped below. However, I believe that, as suggested by Huxley (1940), the primary purpose of subgenera is to indicate relationships between pairs or groups of species in genera, and

therefore that the use of the subgeneric rank in a genus containing only two species is not warranted. The two species included in the genus *Xenopoclinus* are obviously more closely related to one another than to the species for which the other genus, *Cancelloloxus*, was erected, and therefore should be included in one genus.

Key to the species of Xenopoclinus

1. Hook on pectoral girdle well developed. Opercular membranes expanded, overlapping below *Xenopoclinus kochi*
- Hook on pectoral girdle reduced to a small knob, or absent. Opercular membranes not expanded and overlapping below *Xenopoclinus leprosus*

Xenopoclinus kochi Smith, 1947

(Fig. 42)

Xenopoclinus kochi Smith, 1947b: 732, fig. 1, 1949: 358, fig. 1004.

Xenopoclinus (Xenopoclinus) kochi: Smith, 1961: 352, fig. 2.

Description. D. XXXIII-XXXVII (XXXIV-XXXV) 8-11 (9); A. II 29-30; P. 12-13 (12); V. I 3; C. 13. Gill-rakers in outer series on first arch 2 + 0-2. Vertebrae 15 + 34-35. Dorsal fin low, even, anterior spines shortest. Third spine a little shorter than first or fourth. No notch in membrane between third and fourth dorsal spines; spines evenly placed. Soft dorsal rays a little longer than spines. Spines fairly soft. No clusters of cirri at tips of dorsal spines. Pectoral fin with central rays elongate, upswept, fin pointed; lower rays short, curling forward. Pelvic fin of three rays, equal in length, united by membrane from base to tips, resembling a frog's foot. Caudal peduncle short, length 30-40% head length, depth 25-35% head length. Caudal fin subtruncate.

Body elongate, compressed, covered with minute embedded scales not extending on to bases of dorsal, caudal, or anal fins, or head. Depth 6-7.5 in standard length. Head depressed, 3.75-5 in standard length. Snout subacute. Lower jaw projects. Eyes dorsally situated, almost adjacent, 4-6.5 in head. Flat, fleshy papilla over eye. Anterior nostril tubular, cirrus short simple flap. Upper jaw 30-40% head length. Lips moderate. Vomer toothed. Sensory pores of head mostly double, multiple pores in postorbital region (fig. 42(b)). Opercular membranes expanded, overlapping below.

Lateral line of mostly vertical pairs of pores in front to behind pectoral fin; ends abruptly there and is continued below in the mid-lateral line, consisting of short separate horizontal tubes with pore at either end (fig. 42(d)). Intromittent organ of male with long basal portion and rounded tip ensheathed below by two rounded ventro-lateral lips and above by hood-like fold (fig. 42(c)).

Hook on anterior edge of pectoral girdle well developed.

Colouring. Ground colour stony pinkish mauve with about six irregular olive green cross-bars, running into vague olive mottling posteriorly. Cross-bars edged with darker olive. On head behind eyes are two adjacent olive rings. Fins hyaline except dorsal, where olive cross-bars may continue on to fin.

Pectoral base olive. Belly whitish. Dark olive bar at caudal base. Two dark olive blotches on preopercle, sometimes lighter one between; olive stripe from front of eye to upper lip on either side. Speckled and mottled all over body and head with silvery white. Cross-bars more distinct in juveniles. Pupil black, iris gold; papilla over eye white. Pattern retained for some time after preservation.

Location of type material. Department of Ichthyology, Rhodes University, Grahamstown.

Material examined. 13 specimens, 26–73 mm in standard length. 8 from Lambert's Bay, S.A.M. 24667; 5 from Lambert's Bay and Doring Bay, R.U.C. (including holotype).

Distribution (fig. 36). Known only from Lambert's Bay and Doring Bay in southern Namaqualand ($\pm 32^{\circ}00'S.$, $18^{\circ}20'E.$). Not common, in pools and gullies at the bottom of the intertidal zone with much kelp. Burrows in fairly coarse shingly sand.

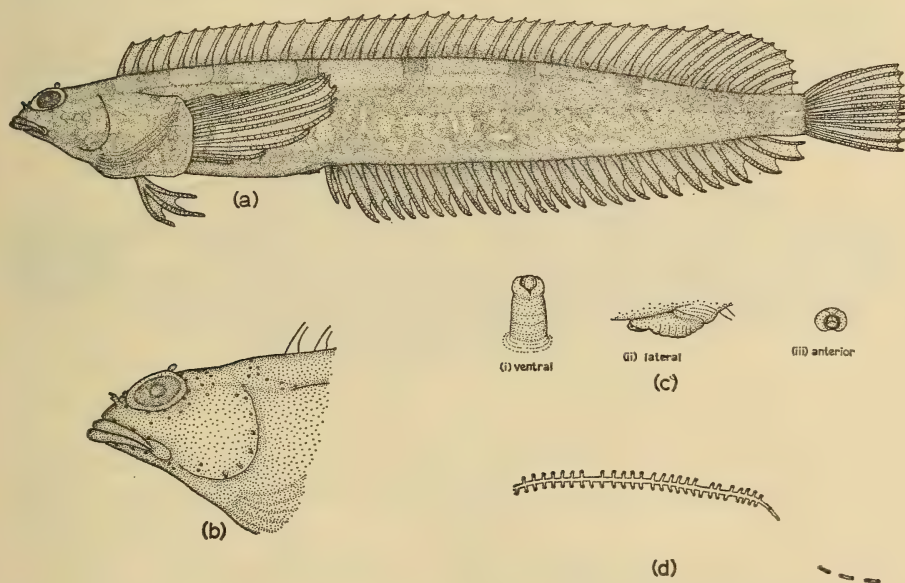


FIG. 42. *Xenopoclinus kochi*: (a) Lateral view, female, 72 mm, S.A.M. 24667; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Xenopoclinus leprosus Smith, 1961
(Fig. 43)

Xenopoclinus (*Xenopoclinops*) *leprosus* Smith, 1961: 354, fig. 3.

Description. D. XXXII–XXXVI (XXXIV–XXXV) 7–12 (9–11); A. II 28–34 (31–32); P. II–13 (11–12); V. I 3; C. 13. Gill-rakers in outer series on first arch 1–2 + 2–5. Vertebrae 15 + 35–36. Dorsal fin low, even, spines

increasing in height posteriorly. Third spine a little lower than fourth or second first may be slightly higher, especially in juveniles. Soft dorsal rays a little longer than spines. Spines soft. Pectoral fin not elongate, slightly upswept, lower rays thickened. Pelvic fin of three equal rays joined throughout length by membrane, resembling a webbed foot. Caudal peduncle short, length 20–33% head length, depth 20–33% head length. Caudal fin subtruncate.

Body elongate, compressed, covered with minute embedded scales not extending on to dorsal, caudal, or anal fin bases or head. Depth 6.25–8.75 in standard length. Head depressed, 4.75–5 in standard length in adults, 4–4.5 in standard length in juveniles. Snout subacute. Eyes dorsal, adjacent, 4–6.5 in head. Flattened, flaplike tentacle over eye, edge irregularly and shallowly notched. Anterior nostril tubular, cirrus flaplike, sometimes terminally notched. Upper jaw 33–43.5% head length. Lips moderate. Vomer toothed. Opercular membranes normal, not expanded or overlapping below. Sensory pores of head mostly double (fig. 43(b)).

Lateral line of vertical pairs of pores and single pores in front to post-pectoral curve, where it ends abruptly; continued in mid-line as short separate horizontal tubes with pore at either end, very obscure in most specimens (fig. 43(d)). Intromittent organ of male with fairly long basal portion and short tip ensheathed by pair of united ventral lips (fig. 43(c)).

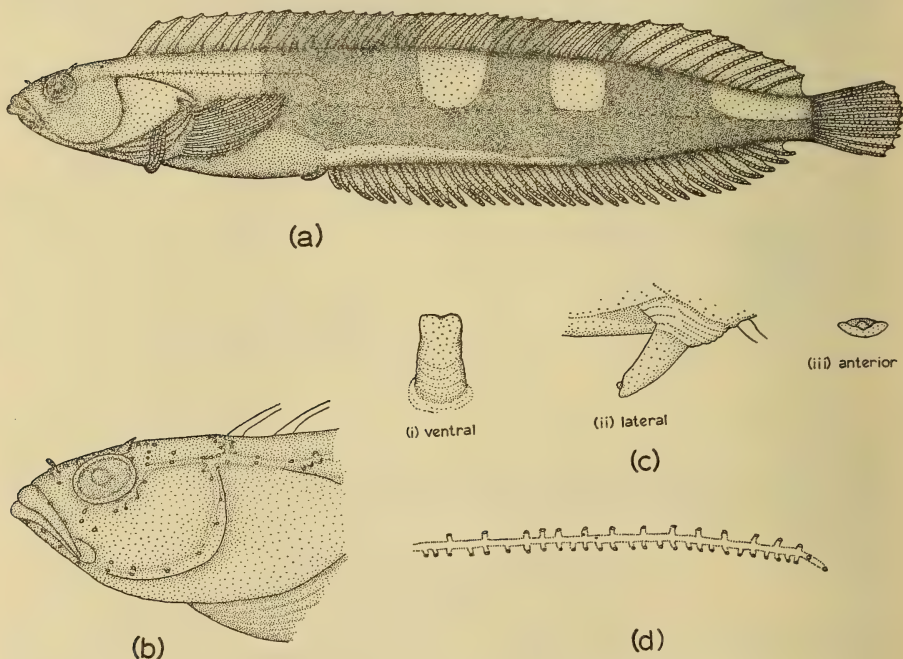


FIG. 43. *Xenopoclinus leprosus*: (a) Lateral view, male, 62 mm, S.A.M. 24668; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Hook on anterior border of pectoral girdle usually absent; if present, reduced to small knob.

Colouring. Ground colour light brown below grading to chocolate above. Three large white saddles in upper half of body. Head white, except for an area, enclosed by a line on each side from dorsal origin to eye and from eye vertically down cheek, which is sand-coloured in life, becoming dark brown or jet black on preservation in spirit. Pectoral base yellow. Dorsal fin brown above dark areas on body, hyaline above white saddles. Other fins hyaline. Iris golden, pupil jet black. Belly light brown to cream. Pattern retained on preservation although colours fade.

Location of type material. Department of Ichthyology, Rhodes University, Grahamstown.

Material examined. 95 specimens, 22–68.5 mm in standard length. 1 off Orange River Mouth, 10 fathoms, U.C.T.; 89 from Lambert's Bay, S.A.M. 24668; 5 from Lambert's Bay, R.U.C. (holotype and paratypes).

Distribution (fig. 36). The known range is Orange River Mouth (28°38'S., 16°24'E) (infratidal, dredged) to Lambert's Bay (32°04'S., 18°20'E) (in intertidal pools and gullies at lowest levels of shore). Burrows in very coarse shingle and broken mussel shells. Fairly common but patchily distributed.

Cancelloxus burrelli Smith, 1961

(Fig. 44)

Cancelloxus burrelli Smith, 1961: 355, figs 1, 4.

Description. D. XXXIV–XXXIX (XXXVI–XXXVII) 10–14 (10–13); A. II 38–43 (41); P. 13–15 (13–14); V. I 3; C. 13. Gill-rakers in outer series on first arch 0–2 + 5–8. Vertebrae: females 20–21 + 44–45, males 19 + 43–46. Dorsal fin low, even, anterior spines lowest, soft rays a little higher than spines. Spines soft. Pectoral fin with middle rays elongate, pointed and upswept, lower rays thickened. Pelvic fin of three equal rays, joined from bases to tips by membrane, resembling a webbed foot. Dorsal fin originates well behind head. Caudal peduncle short, length 23.5–31% head length, depth 20–28.5% head length. Caudal fin subtruncate.

Body elongate, compressed, covered sparsely with minute scales not extending on to dorsal, caudal, or anal fin bases, or head. Depth 8–11 in standard length. Head depressed, 4.25–5.5 in standard length, snout pointed. Eyes oval, adjacent, 3.75–4.75 in head. No tentacle or papilla over eye. Anterior nostril tubular, cirrus small simple flap. Upper jaw 26–29% head length. Lips fairly thick. Lower lip produced at symphysis into acute process. Vomer edentate. Few or no teeth at sides of jaw, patch at each symphysis. Opercular membranes normal, not expanded or overlapping below. Sensory pores of head mostly single, opening flush with skin surface (fig. 44(b)).

Lateral line of single pores opening more or less medially in front, then of short separate horizontal tubes with pore at either end, sloping gradually to

mid-line behind pectoral fin (fig. 44(d)). Intromittent organ of male extremely large. Basal portion long and stout, terminating anteriorly in pair of horn-like lobes between which tip protrudes. Tip conical, curving up towards belly. Flat fleshy lobe dorsally at base of tip. Belly of male deeply grooved. Intromittent organ illustrated in fig. 44(c). Vent of female large and crescent-shaped, surrounded by fleshy fold produced posteriorly into two lobes, one on either side of first anal spine. Each lobe with thick fleshy dorsal portion overlaid by thin skinny lobe ventrally.

Colouring. Ground colour cream, semi-translucent. Bright silver broken stripe mid-laterally. Irregular olive patches above. Eleven olive saddles above, edged darker. Olive stripe from eye to posterior edge of opercle; below this stripe a broad silver stripe. Lips and underparts cream. Pectoral base silver. Fins hyaline. Pupils jet black, iris narrow and golden. In alcohol the ground colour becomes opaque and the olive turns golden brown, later fades completely.

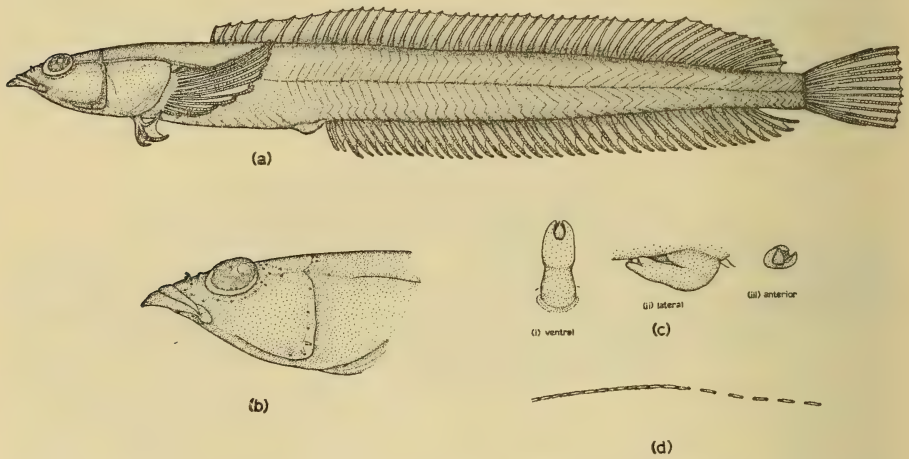


FIG. 44. *Cancellotus burrelli*: (a) Lateral view, female, 105 mm, S.A.M. 24669; (b) Head pore system; (c) Intromittent organ of male; (d) Lateral line.

Location of type material. Department of Ichthyology, Rhodes University, Grahamstown.

Material examined. 19 specimens, 75.5–107 mm in standard length. 1 from off Orange River Mouth, 5 fathoms, S.A.M. 23272; 1 from Lambert's Bay, R.U.C. (holotype); 3 from Lambert's Bay, R.U.C. (paratypes); 14 from Lambert's Bay, S.A.M. 24669.

Distribution (fig. 36). The known range is Orange River Mouth (28°38'S., 16°24'E.) (infratidal, 5 fathoms) to Lambert's Bay (32°04'S., 18°20'E.), mainly in gullies and inlets open to the sea at the base of the intertidal zone, in coarse shingle. Not common.

ORIGIN OF THE SOUTH AFRICAN CLINIDAE

The presence of a hooklike projection on the anterior border of the cleithrum, small scales with radii on all margins, and the very similar general appearance of the less specialized members of both groups, point to a common origin of the Myxodini and the Clinini. Hubbs (1952) considered the Myxodini to be ancestral to the Clinini because the Myxodini are oviparous, fertilization is external, and there is no intromittent organ in the male.

The derivation of the South African species from the most generalized of the American myxodids, the species of the genus *Gibbonsia*, would not be difficult. If one of the American species such as *Gibbonsia metzi* C. L. Hubbs were to develop viviparity, the result would be a clinid very similar to some of the more generalized South African clinids such as *Clinus robustus*. I examined specimens of *Gibbonsia*, *Myxodes*, and *Heterostichus*, and, apart from the lack of an intromittent organ in the male, they are strikingly similar to the South African clinids.

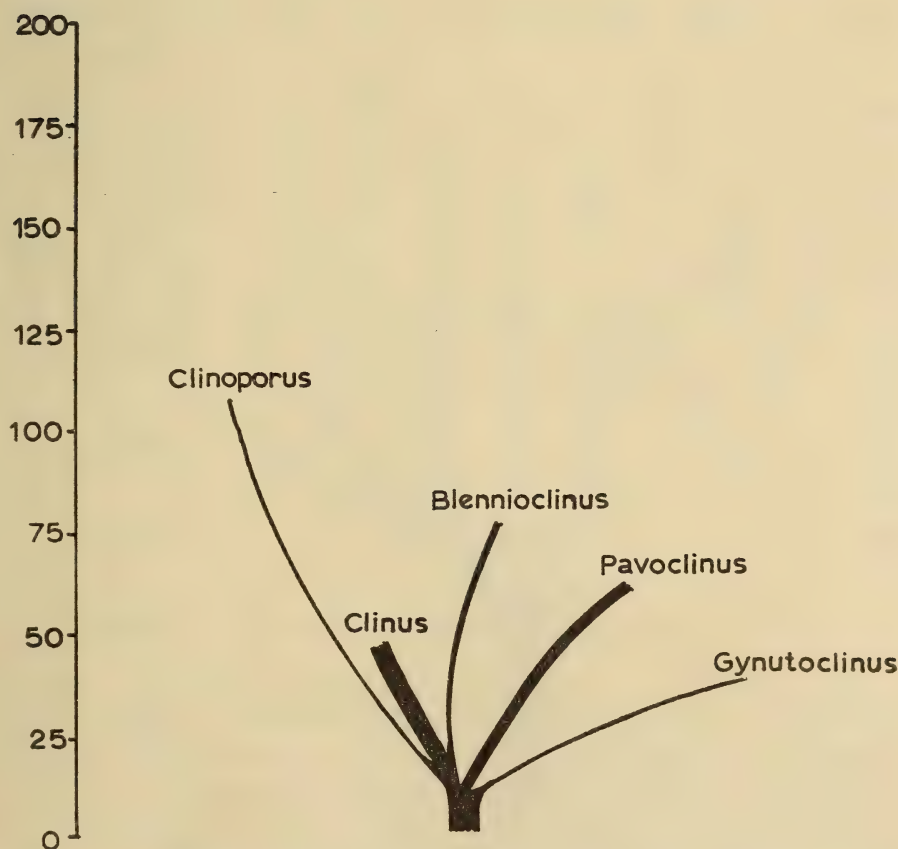


FIG. 45. Hypothetical intergeneric relationships of South African Clinidi.

In a consideration of the origins of a group it is often difficult to decide which characters are primitive and which are advanced. Table 8 gives what I consider to be the primitive condition for twenty characters which have been used in my study. In some cases the definition of the primitive condition is based on the statements of Hubbs (1953*b*) regarding typically clinid characters, and in others on the conditions prevailing in the genus *Gibbonsia*.

Of the two subtribes of Clinini represented in South Africa, the Clinidi have by far the greatest representation, with five genera and 30 species in South African waters. The genera apparently represent two major lines of evolution and three minor ones. The hypothetical intergeneric relationships are shown in figure 45. The method used for devising the figure is similar to that used by Stephens (1963). The lateral position is based purely on morphological resemblance and the horizontal distances are arbitrary, but the vertical position indicates the 'primitiveness' of the genera. The 'primitiveness' is determined by the number of points awarded for each of the twenty characters listed in table 8, from no points for the 'primitive' condition of a character up to ten points for an 'advanced' condition. The thickness of the lines indicates the relative number of species.

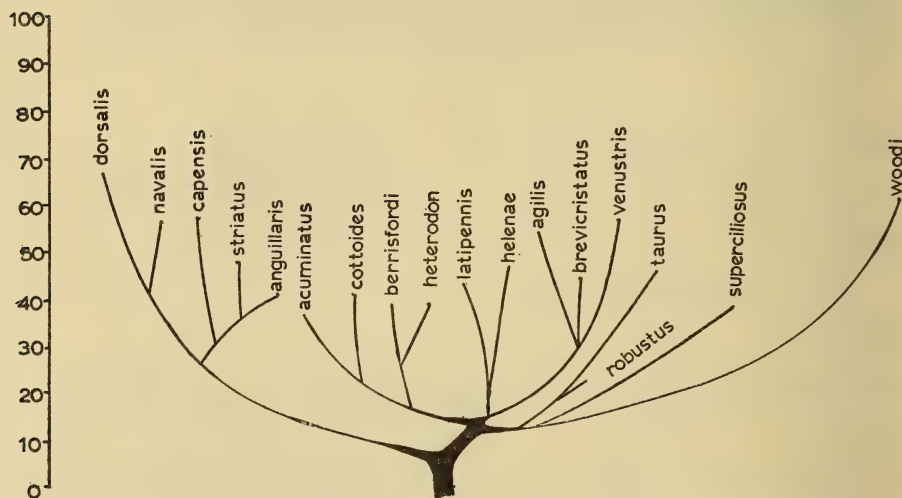


FIG. 46. Hypothetical interspecific relationships of the South African genus *Clinus*.

The two major lines, leading to the genera *Clinus* and *Pavoclinus*, retain a fairly high number of 'primitive' characters, but these are not the same in the two groups; for instance, the supraorbital tentacle is retained in *Clinus* but lost in *Pavoclinus*, whereas the 'primitive' arrangement of the anterior dorsal spines for this group is retained in several of the species of *Pavoclinus*, but in none of the species of *Clinus*. The species of *Pavoclinus* are more specialized for a particular habitat than are the species of *Clinus*.

In the genus *Clinus* there appears to have been a tendency to reduce the height of the anterior dorsal spines. (This tendency is apparently paralleled in the Labrisomini (Hubbs, 1953b).) In those species of *Clinus* in which the anterior dorsal spines are high, the membrane, especially that between the third and fourth dorsal spines, is incised to a greater or lesser degree; this is also

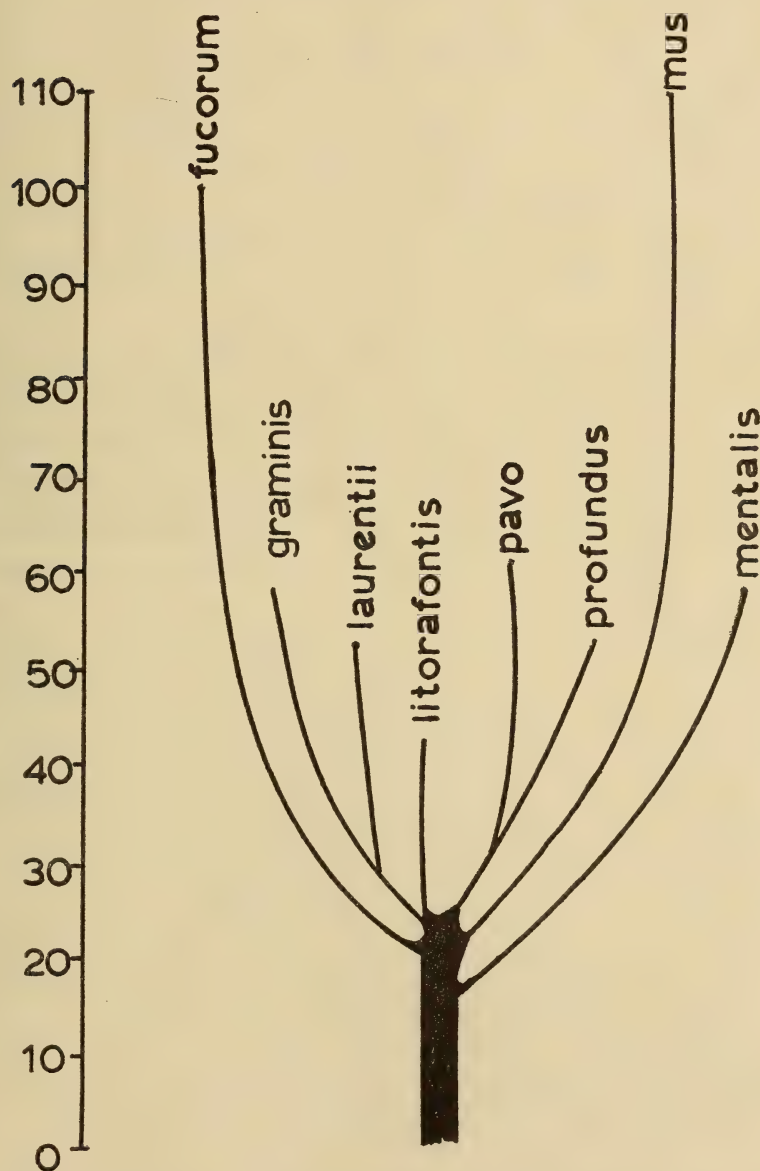


FIG. 47. Hypothetical interspecific relationships of the South African genus *Pavoclinus*.

the case in two species in which the anterior spines are low. In three of the four subgenera (comprising, however, less than one third of the species in the genus) there is a tendency towards elongation of the body and an eel-like habit. These forms are thought to have diverged early from the main branch (see fig. 46, *Clinus anguillaris*, *C. striatus*, *C. capensis*, *C. dorsalis* and *C. navalis*). All the species involved show considerable specialization, which would have required a relatively long time, yet retain certain primitive characters such as the facial and supraopercular scales in the subgenus *Blennophis* and the facial scales in the subgenus *Cirrhobarbis*. All the less specialized species of *Clinus* have the head region completely naked, except for *C. woodi*, which retains three supraopercular scales on either side. The tendency to reduction of scaling in the head region has occurred in all the genera of South African Clinini, most of which lack scales on the head, and the scaling of the fin bases has become reduced as well.

Figure 46 shows the hypothetical inter-relationships of the species of *Clinus*. The figure has been drawn up in the same way as figure 45, using the characters listed in table 8.

All the species of the genus *Pavoclinus* are modified for a weed-dwelling habit. The supraorbital tentacle has been lost, and in this feature they are more 'advanced' than the species of *Clinus*, but the arrangement of the dorsal fin in *Pavoclinus graminis*, *P. litorafontis* and *P. pavo* is very similar to that of the species of *Gibbonsia*, and is therefore considered to be primitive. As in the genus *Clinus* there has been a reduction in the extent of the scaling, and in all the species of *Pavoclinus* the head region is entirely naked. The hypothetical relationships of the species are shown in figure 47, which has been drawn up in the same way as figures 45 and 46.

The subgenus *Labroclinus*, containing one species (*Pavoclinus mentalis*), may have diverged fairly early. It retains several 'primitive' features; the fin counts are higher than those in the other subgenera of *Pavoclinus*, being similar to the intermediate fin counts of the *Clinus* (*Clinus*) group of species; the dorsal and caudal fin bases are scaled; the vomer is toothed, and the caudal peduncle is only moderately elongate. On the other hand, it has apparently specialized features such as the complete separation of the dorsal crest and the skinny flap on the lower jaw symphysis. It presumably arose by specialization from a form such as *Pavoclinus laurentii*, which has a separate dorsal crest.

The other two monospecific subgenera, *Fucomimus* and *Smithichthys*, are highly specialized weed-dwellers and retain very few 'primitive' characters. The fin counts are reduced, the scales are minute and do not extend to the median fin bases, the vomer is edentate, and the caudal peduncle is very long. *Pavoclinus* (*Fucomimus*) *mus* has a separate dorsal crest, and a low number of dorsal soft rays; the number of caudal rays is reduced to eleven. *Pavoclinus* (*Smithichthys*) *fucorum* has a peculiar form of crest with at least the first four dorsal spines involved, an upturned snout, and the teeth reduced to one row in each jaw. The lack of vomerine teeth in the subgenera *Fucomimus* and *Smithichthys* is paralleled in the South American genus *Myxodes*, to which the species

Pavoclinus (*Smithichthys*) *fucorum* was referred by Smith (1945).

The remaining species constituting the subgenus *Pavoclinus* form a relatively compact group; in one of the five species the fin membrane is incised between the third and fourth dorsal spines, and in one of the species, *Pavoclinus profundus*, the anterior dorsal spines are low, and the scales are minute.

The three remaining genera are minor groups and have undergone little or no speciation.

Blennioclinus is apparently not close to any of the other genera, but in the character of the anterior part of the lateral line and in the body form and habit resembles *Clinus* rather than *Pavoclinus*. The notch in the profile of the dorsal fin before the dorsal soft rays in this genus is unique in the Clininae, although it commonly occurs in the labrisominid genera *Labrisomus* and *Malacoctenus* (Springer, 1958, pls. I-VII). However, as *Blennioclinus* clearly belongs to the Clininae, it is difficult to see how this character may have developed. In this connexion it is interesting to note that there are various features which appear scattered throughout the clinids in apparently not very closely related forms. Examples are the flap of the skin on the lower jaw symphysis developed in some of the American tribe Paraclinidi, e.g. *Paraclinus barbatus* Springer (Springer, 1954, fig. 1), in *Pavoclinus mentalis* (fig. 29), in *Cancelloxus burrelli* (fig. 44) and in members of the related family Chaenopsidae, e.g. *Chaenopsis alepidota alepidota* (Gilbert) (Stephens, 1963 pl. 12); the reduction of the number of dorsal soft rays to one in the Paraclinidi (Hubbs, 1952) and the subgenera *Climacoporus* and *Muraenoclinus* of the genus *Clinus*; and the development of the hook on the pectoral girdle, so characteristic of the Clininae, in the adults of two Labrisominae, *Malacoctenus erdmani* Smith and *Malacoctenus aurolineatus* Smith (Springer, 1958). I believe that these shared characters are strong evidence for a monophyletic origin of the Clinidae as a whole.

Clinoporus, the most specialized of the five South African genera of Clinini, is apparently most closely related to the genus *Clinus* and may have been derived from the line leading to the eel-like species of *Clinus* by loss of the scales and modifications of the lateral line. Since the single species, *Clinoporus biporosus*, is the only species of the South African Clinini (other than the little-known *Pavoclinus profundus*) that is normally taken in relatively deep water beyond the limits of the infratidal fringe, it might be expected to differ markedly from the predominantly intertidal Clinidae.

Gynutoclinus retains the greatest number of 'primitive' characters, although the peculiar form of the head excludes it from the direct line of descent of any of the other genera. The rarity of its single species suggests that it has not proved as successful in those habitats where it has been taken as at least three of the other four genera; *Clinoporus* is also represented by a single, apparently rare species, but the inaccessibility of the usual habitat of *Clinoporus* may contribute considerably to the impression of rarity.

Gynutoclinus has features in common with both *Pavoclinus* and *Clinus*, but it appears to have followed an independent pattern of evolution. The intro-

mittent organ of the male is similar to the type found in the genus *Clinus*, and there is a vestigial supraorbital tentacle; the characters shared with *Pavoclinus* are chiefly those associated with adaptation to a weed-dwelling existence.

The other subtribe, the *Xenopoclinidi*, apparently have a common derivation with the *Clinidi* from a myxodidlike ancestor, and the high degree of

Table 8. Characters used in the consideration of specialization in South African *Clinini*.

Characters	'Primitive' condition
Presence or absence of scales on body	Scales present
Degree of scaling on head	Scale patches on cheek and above opercle.
Degree of scaling on median fin bases	Scales on dorsal, caudal, and anal fin bases
Arrangement of jaw teeth	A row of small teeth behind front row of jaw teeth
Presence or absence of teeth on vomer	Vomer toothed
Position of dorsal fin origin	Over hind margin of preopercle
Height of anterior dorsal spines	First three dorsal spines higher than succeeding spines
Presence or absence of a notch in membrane between third and fourth dorsal spines	Notch in membrane absent
Number of dorsal spines	30-40
Number of dorsal rays	5-10
Number of anal rays	20-30
Development of third pelvic ray	Stout, equal to other two
Arrangement of posterior part of lateral line	Short separate horizontal tubes with a pore at either end
Arrangement of anterior part of lateral line	Single pores opening more or less medially
Presence or absence of supraorbital tentacle	Supraorbital tentacle present
Shape of head	Compressed, not inflated
Snout shape	Sloping to mouth, not upturned
Presence or absence of facial barbels	Facial barbels absent
Condition of jaw symphysis	Smooth, without projecting skinny flap
Length of caudal peduncle	Short to moderate, 20-40% of head length

specialization of this group suggests that the divergence probably occurred early. It is possible to derive the Xenopoclinidi from a form tending towards elongation of the body such as might have given rise to *Clinoporus* and the eel-like species of *Clinus*.

Note on the geographical origin of the Clininae

As can be seen from figure 1, the Clinidae are a widespread family, occurring in the tropics and the temperate regions of the southern hemisphere. Because the greatest occurrence of the family as a whole is in the tropics of Central America, this region has been considered to be their centre of origin (Hubbs, 1952; Springer, 1958). The South African and Indo-Australian forms are all viviparous and have been considered to have spread to those regions from America some time after the origin of the group; closely related oviparous forms occur in South America. Most of the clinids of the Pacific coast of America and all the clinids except two species of the Atlantic coast of America belong to the apparently more primitive subfamily the Labrisominae. The subtribe Calliclinidi, which Hubbs (1952) considered to be the most primitive of the Labrisominae, is apparently confined to the Pacific coast of South America. The tribe Neoclinini, also primitive but of rather uncertain systematic position, is also confined to the eastern Pacific, with one, or at most a few, representatives in Japan, the Ryukyus and Korea.

It has generally been assumed that the Clininae and the Labrisominae have had a common origin, and this view is supported by the shared features listed in the previous section. However, it is as well to remember that insufficient comparison has been made between the Labrisominae and the Clininae to determine whether either could actually be ancestral to the other; on the whole a common origin from a more primitive group is most probable.

Briggs (1955), following Matthew (1915), considered the centre of origin or 'centre of dispersal' of a group to be that area in which the most progressive species of the group are found, rather than the area where the greatest number of species, regardless of their state of advancement, occur. The most primitive species are then found to have a peripheral distribution about this area.

If the Labrisominae and the Clininae are considered separately, the following emerges: the most progressive Labrisominae undoubtedly occur in the tropical waters of Central America. The Calliclinidi occur on the periphery of this region, in temperate Pacific South American waters. But the most progressive Clininae do not occur in the American region; they occur in the temperate waters of South Africa and Australia. The more primitive Clininae, the Myxodini, the Japanese *flammeus* with its small intromittent organ, and probably the Mediterranean clinid, occur mainly on the periphery of this region. This suggests, then, that the Labrisominae had an Atlanto-East-Pacific origin, whereas the Clininae had an Indo-West-Pacific origin.

Briggs (1955) pointed out that it has been proved for several plant and land animal groups, where there is an extensive fossil record, that their centre

of origin lies far from the area in which their greatest modern occurrence lies. Unfortunately the inadequacy of the Tertiary fish fossil record has made it necessary to rely to a large extent on modern distribution alone. However, there are some indications that the Labrisominae may have originated and undergone at least some radiation in the Tethys Sea before conditions there became unsuitable for a tropical group, and that they then became established and underwent extensive radiation in the Atlanto-East-Pacific while the Pacific and Atlantic coasts of Central America were still in free communication. *Labrisomus nuchipinnis* (Quoy & Gaimard) occurs on the tropical Atlantic coast of America, in the West Indies, the Madeira Islands, the Canary Islands, the Cape Verde Islands and the coast of tropical West Africa as far south as Moçamedes in Angola. *Malacoctenus africanus* (Cadenat) has been recorded from Dakar, Senegal, in West Africa. Arambourg (1921, 1927, 1943), described a fossil species which he called *Labrisomus pronuchipinnis* from the Miocene Tethys deposits of Algeria. He referred it to the relatively small category of Mediterranean fossil species having their main affinities with the fauna of the Atlantic (Arambourg, 1943). Steinitz (1950, q. Hubbs, 1953*b*) believed the occurrence of *Labrisomus nuchipinnis* in West Africa to date from the time of the Tethys Sea. Hubbs (1953*b*) and Springer (1958) disagreed with this view, because they considered that a species could not remain undifferentiated on both sides of the Atlantic for so long a time, and Hubbs (1953*b*) suggested that the fact that *Labrisomus nuchipinnis* apparently has a rather longer pelagic larval stage than is usual for clinids might account for its transport across the Atlantic. However, the species of *Malacoctenus* apparently have a particularly short larval stage (Springer, 1958), so that this would not account for the occurrence of a species of *Malacoctenus* in West Africa, if it is assumed to be derived from the American species of *Malacoctenus*. To explain the occurrence of *Labrisomus pronuchipinnis* in Mediterranean deposits and the occurrence of *Labrisomus nuchipinnis* and *Malacoctenus africanus* in West Africa, we must, if the group is considered to be American in origin, postulate a Tethys crossing for *Labrisomus pronuchipinnis* and two recent crossings for the two modern species. The two recent crossings, at least, are not favoured by the prevailing current systems, although this appears often to be the case in shore fish distribution (Briggs, 1967). Perhaps as far as the Labrisominae are concerned it might be preferable to agree with Steinitz (1950) and to suggest that, although on the whole one would expect genetically isolated populations such as the American and West African *Labrisomus nuchipinnis* to become specifically distinct, *Labrisomus nuchipinnis* is clearly a robust and successful species where it occurs, and it may have had no tendency to undergo any change. This latter is not surprising, since Ekman (1953) pointed out that the West African region is in fact a faunally poor area that few groups have found suitable for extensive radiation. *Labrisomus nuchipinnis* may be the exception that proves the rule regarding isolated populations; whether we regard it as exceptional as regards speciation or exceptional as regards crossing the Atlantic from America to Africa, it remains an exception;

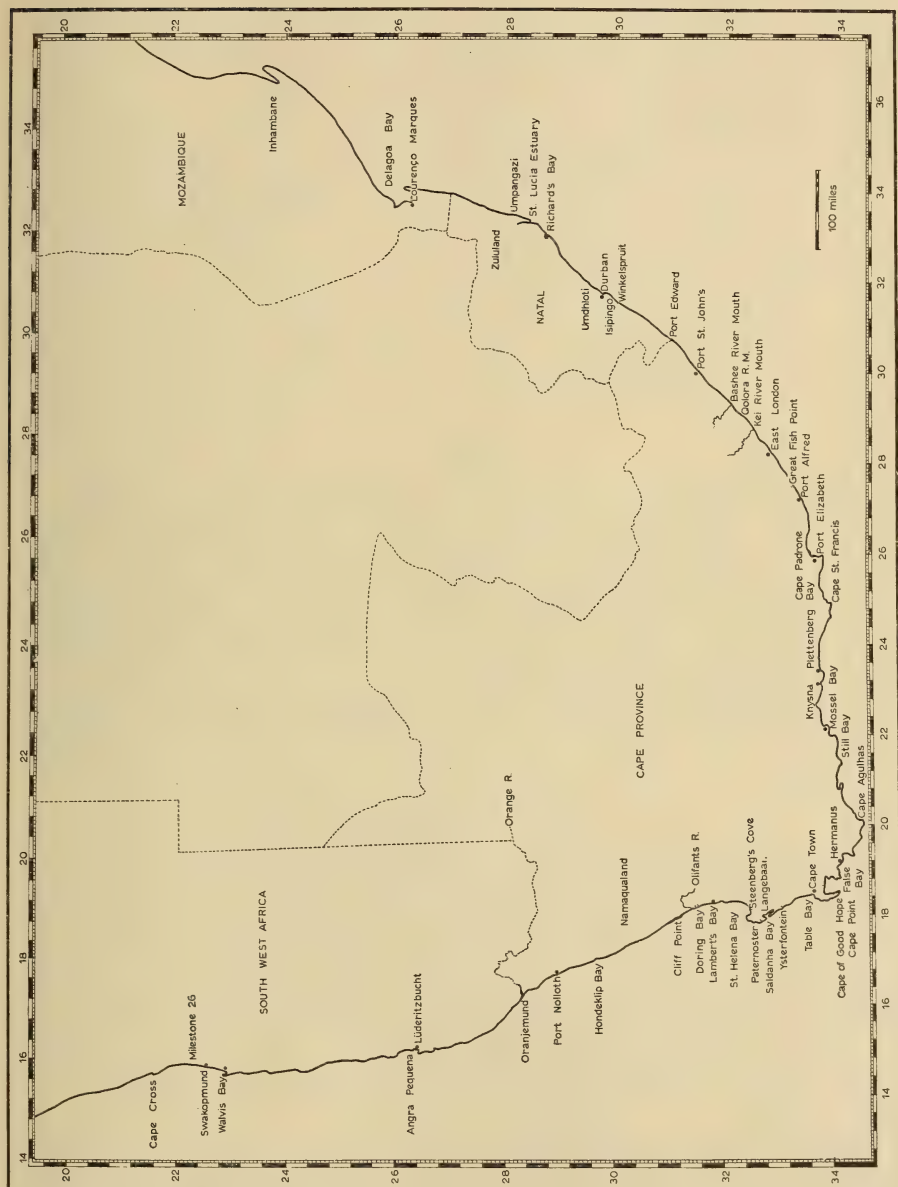


FIG. 48. Map of southern Africa showing the localities referred to in the text. Rocky Point, the northernmost point on the South West African coast at which a clinid was collected, is not shown but it lies 210 miles north of Cape Cross.

at least by adopting the former view *Labrisomus pronuchipinnis* and *Malaccoctenus africanus* do not have to be regarded as similarly exceptional.

It seems possible that the common stock which gave rise to these two sub-families was a tropical Tethys Sea group which, in common with most of the early Tertiary Thethys fauna, died out when climatic conditions changed. Ekman (1953) noted that both the Indo-West-Pacific and the western Atlantic (Atlantic-East-Pacific region) received forms from the Tethys Sea which are now either no longer predominant or are no longer found at all in the Mediterranean or the eastern Atlantic. The Atlanto-East-Pacific would then have received the Labrisominae, already to some extent differentiated, from the Tethys Sea, and these forms would have found this area highly suitable for adaptive radiation. The Clinidi, on the other hand would have become established in the temperate Indo-West Pacific and there undergone adaptive radiation and developed viviparity. The Myxodini may either have reached South America by crossing the eastern Pacific from the Indo-West-Pacific, or may have arisen separately from the viviparous Indo-West-Pacific Clinini. The latter seems more likely; the hook on the pectoral girdle may not indicate as close a relationship as it has been thought to do, since it does appear in two Labrisominae. In any case, if the forerunners of the Clininae were present in the Tethys Sea, it is possible that some migrated to the Indo-West-Pacific and gave rise to the viviparous Clinini, while others, very similar, migrated with the Labrisominae to the Atlanto-East-Pacific and there gave rise to the Myxodini. However, such considerations of the zoogeographical origin of a group are always of a highly speculative character.

The mechanism of such dispersal of virtually sedentary forms, whether now or in Tertiary times, is of course unknown. Ekman (1953) stated that the only conceivable method of dispersal over long distances for forms with a short or no pelagic larval period is by attachment to or entanglement in sea-weed. He cited two cases of wide distribution of viviparous echinoderms which he considered could have occurred in no way other than by transport in sea-weed. One is the brittle-star *Amphipholis squamata* (Della Chiaje), which occurs from the Red Sea to South Africa, Hawaii, the Society Islands and the west coast of America; it also occurs at the southern tip of Patagonia, indicating that it was transported round Cape Horn. It is obviously far more eurythermic than any of the Clinidae. The other is the starfish *Asterina exigua* (Lamarck), endemic to South Africa, which also occurs on the island of St. Helena, where it was apparently carried in drifting material from South Africa by a branch of the Benguela current.

The transport in sea-weed of the ancestor of, for instance, the Australian Clinini from South Africa is quite likely. It would be quite possible for a weed-dwelling clinid to live for a fairly long period of time in a floating mass of weed, provided that the food supply lasted until land was reached, and to become established in the new area if conditions were suitable. Viviparity would favour this type of dispersal, since only one gravid female would be

needed to carry quite a large number of fishes to the new area.

Finally it may be said that there is a modern record of a clinid surviving a long journey when being transported by a ship, although the specimen met with a fate on arrival that precluded its becoming established in the new area.

Clinus nautilus (Barnard) was first described from a specimen recovered from amongst barnacles on a ship's bottom at Simonstown in False Bay, Cape Peninsula, some two hundred miles west of the western limit of the range of the species, and some five hundred miles west of the last port where it could have been picked up. It was apparently found in good health.

I am not suggesting that this example can be used to explain the distribution of, for instance, the West African clinids, since their existence in Africa obviously antedates regular ship crossings; the example is merely given to show that clinids can survive passive transport at least over a short period, by ships, and the underside of ships, discharging oil, etc., might be considered to be a less hospitable environment than a free-floating raft of weed.

SUMMARY

This work consists of a systematic revision of the South African Clinidae. The relationships of the South African Clinidae with the Clinidae of other parts of the world are briefly considered. Classification of the South African Clinidae above the generic level is revised, and the several South African clinid species are regrouped in seven genera, which arrangement seems to reflect the natural relationships within the group better than the previous assemblage of small genera. The family Xenopoclinidae Smith, 1961 is included in the family Clinidae. Some comment is made on the evolution and zoogeography of the Clinidae.

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APPENDIX A. Data for fig. 3 (comparison of upper jaw lengths of South African Clinidi).
(Data as % of head length.)

				Std. dev.	Std. err.	Std. err. × 2	No. of fish
		Range	Mean	σ	σm	$2\sigma m$	N
<i>Clinus anguillaris</i>	.. ..	36.3-43.0	40.0	0.35	0.07	0.14	25
<i>Clinus striatus</i>	.. ..	37.0-44.5	40.2	—	—	—	9
<i>Clinus capensis</i>	.. ..	37.8-47.5	43.7	2.48	0.51	1.02	25
<i>Clinus dorsalis</i>	.. ..	34.8-50.0	40.1	3.63	0.74	1.48	25
<i>Clinus navalis</i>	.. ..	38.0-44.5	40.7	—	—	—	5
<i>Clinus acuminatus</i>	.. ..	35.7-45.5	40.2	2.53	0.52	1.04	25
<i>Clinus agilis</i>	.. ..	40.0-50.0	44.2	2.46	0.52	1.04	25
<i>Clinus berrisfordi</i>	.. ..	36.4-50.0	43.3	3.94	1.02	2.04	16
<i>Clinus brevicristatus</i>	.. ..	38.5-46.5	41.7	1.70	0.36	0.72	23
<i>Clinus cottoides</i>	.. ..	43.7-60.0	49.1	4.17	0.85	1.70	25
<i>Clinus helenae</i>	.. ..	39.5-52.5	44.3	—	—	—	3
<i>Clinus latipennis</i>	.. ..	34.5-43.5	39.3	—	—	—	3
<i>Clinus heterodon</i>	.. ..	36.4-50.0	44.2	4.26	0.87	1.74	25
<i>Clinus robustus</i>	.. ..	45.5-53.5	49.4	—	—	—	8
<i>Clinus superciliosus</i>	.. ..	33.3-45.0	41.2	2.85	0.58	1.16	25
<i>Clinus taurus</i>	.. ..	38.1-53.0	44.4	4.36	0.97	1.94	19
<i>Clinus venustis</i>	.. ..	35.3-48.0	41.2	3.92	0.82	1.64	25
<i>Clinus woodi</i>	.. ..	48.0-51.5	49.8	—	—	—	5
<i>Pavoclinus mus</i>	.. ..	26.7-37.5	29.8	2.24	0.46	0.92	25
<i>Pavoclinus graminis</i>	.. ..	27.6-38.6	33.0	2.45	0.51	1.02	25

<i>Pavoclinus laurentii</i>	..	..	36.0-41.0	39.0	1.39	0.40	0.80	12
<i>Pavoclinus litorafontis</i>	..	..	33.3-42.5	37.9	2.11	0.45	0.86	22
<i>Pavoclinus mentalis</i>	..	..	35.0-40.5	37.0	—	—	—	6
<i>Pavoclinus pavo</i>	..	..	22.0-43.0	32.6	4.36	0.89	1.78	25
<i>Pavoclinus profundus</i>	..	..	36.4	36.4	—	—	—	1
<i>Pavoclinus fucorum</i>	..	..	32.4-42.0	38.3	—	—	—	8
<i>Blennioclinus brachycephalus</i>	..	..	28.6-36.1	32.4	2.06	0.42	0.84	25
<i>Blennioclinus stella</i>	..	..	37.5-47.5	42.2	—	—	—	5
<i>Clinoporus biporosus</i>	34.1-43.0	38.3	—	—	—	6
<i>Gymnoclinus rotundifrons</i>	40.0-43.5	42.0	—	—	—	3

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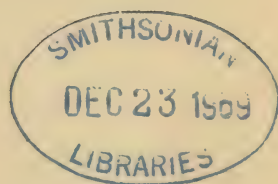


APLETODON PELLEGRINI (CHABANAUD) AND
OTHER CLINGFISHES (PISCES: GOBIESOCIDAE)
FROM SOUTH WEST AFRICA

By

MARY-LOUISE PENRITH

Cape Town Kaapstad



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South African Museum, Cape Town

(With 5 figures)

[MS. received 14 May 1969]

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INTRODUCTION

It is not unusual that the presence of a group such as the clingfishes, most of which are small and inconspicuous, should remain undetected in areas in which very little collecting has been done. Smith (1964), discussing the clingfishes of the western Indian ocean and the Red Sea, pointed out that no clingfishes had up to that time been recorded from tropical West Africa south of Ghana. His distribution maps showed no records of Gobiesocidae on the western African coast between Ghana in the north and Port Nolloth in the south.

Smith (1964) suggested that the lack of records of Gobiesocidae from the west coast of Africa was probably due rather to lack of sampling of the area than to a genuine deficit of clingfishes there, and this appears to be true. Collecting on the South West African coast by the South African Museum and the State Museum, Windhoek, has indicated that three species of Gobiesocidae occur intertidally in South West Africa, and one of these has also been found in southern Angola.

Smith (1964) listed five species of Gobiesocidae (*Apletodon knysnaensis* Smith, *Chorisochismus dentex* (Pallas), *Eckloniaichthys scylliorhiniceps* Smith, *Lepadichthys coccinotaenia* Regan, *Pherallodus smithi* Briggs) as occurring intertidally in the South African region. Of these, *Pherallodus smithi* is known from the single type specimen collected at Durban in 1934, and *Lepadichthys coccinotaenia*, a species of the tropical western Indian ocean, occurs rarely on the Natal coast. The other three species are found further westwards. Briggs (1955) recorded four species from north-west African shores and islands (*Apletodon pellegrini* (Chaba-

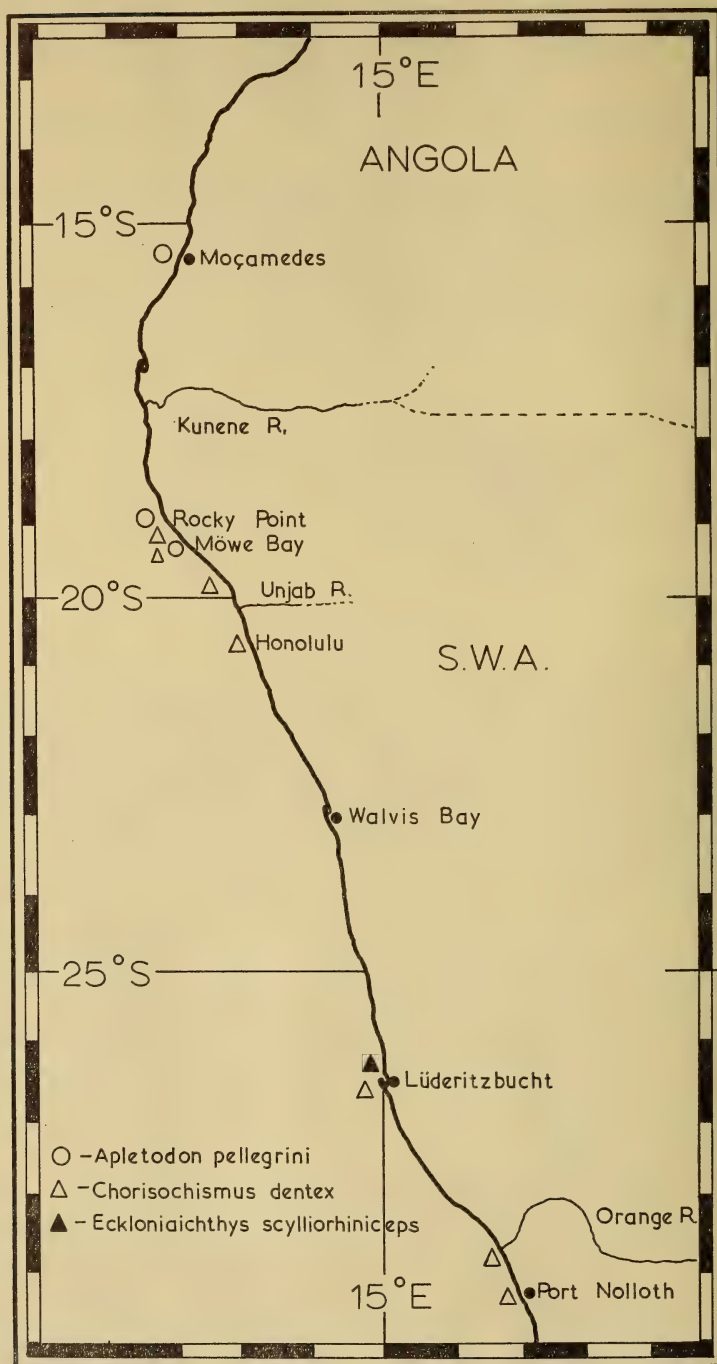


Fig. 1. Records of clingfishes from the South West African region.

naud), *Lepadogaster candollei* Risso, *Lepadogaster lepadogaster lepadogaster* (Bonna-terre), *Lepadogaster zebrina* Lowe), while the genus *Diplecogaster* is represented in deeper water in this area, as it is off southern Africa (Briggs, 1955; Smith, 1964). Two specimens of *Apletodon pellegrini* in the Muséum d'Histoire Naturelle, Paris, collected at Annobón island just south of the equator by A. Stauch, represent the southernmost record for any clingfish in the West African tropical region.

The three species here recorded from South West Africa are *Chorisochismus dentex*, *Eckloniaichthys scylliorhiniceps*, and *Apletodon pellegrini*. The localities from which these species were recorded are shown in figure 1. The South West African records of *Chorisochismus dentex* and *Eckloniaichthys scylliorhiniceps* represent considerable north-westward extensions of their distributional ranges.

The identification of the South West African specimens of *Apletodon* necessitated comparison with both northern and southern (*Apletodon knysnaensis*) specimens, and this comparison led me to conclude that *Apletodon pellegrini* and *A. knysnaensis* are not specifically distinct in spite of their apparent geographical separation.

Abbreviations used

P.M. — Muséum d'Histoire Naturelle, Paris.

R.U.C. — J. L. B. Smith Institute of Ichthyology, Rhodes University, Grahamstown.

S.A.M. — South African Museum, Cape Town.

S.M. — State Museum, Windhoek, South West Africa.

U.Z.M. — Universitets Zoologiska Museum, Copenhagen, Denmark.

SYSTEMATIC DISCUSSION

Apletodon pellegrini (Chabanaud, 1925)

(Fig. 2)

Lepadogaster (Mirbelia) Pellegrini Chabanaud, 1925: 283, 286.

Apletodon pellegrini: Briggs, 1955: 27 (synonymy and references). Blanc, Cadenat & Stauch, 1968: 252.

Apletodon knysnaensis Smith, 1964: 590, pl. 93 B, C, pl. 96 A-F, pl. 97 B-F.

Material on which description is based: 1 specimen, 29 mm standard length, S.A.M. 24942, intertidal pool, Moçamedes, southern Angola; 1 specimen, 26 mm standard length, S.M. 5216, intertidal pool, Rocky Point, S.W.A.; 2 specimens, 25 & 22 mm standard length, S.A.M. 25247, intertidal pools, Rocky Point, S.W.A.; 1 specimen, 34 mm standard length, S.A.M. 25263, intertidal pool, Rocky Point, S.W.A.; 2 specimens, 42 & 32 mm standard length, S.A.M. 25257, intertidal pools, Möwe Bay, S.W.A.; 1 specimen, 34 mm standard length, S.M. 5268, intertidal pool, Möwe Bay, S.W.A.

Other material examined: 3 specimens, P.M. 25-239, 25-240, 25-241, Cap

Blanc (syntypes); 1 specimen, P.M. 07-257, Senegal (syntype); 2 specimens, P.M. 59-65, 59-66, Senegal; 2 specimens, P.M. 1965-623, Annobón Island; 3 specimens, U.Z.M., Senegal (Dakar); 1 specimen, R.U.C., Knysna (allotype of *A. knysnaensis*); 1 specimen, R.U.C., Knysna (holotype of *A. knysnaensis*); 5 specimens, R.U.C., Knysna; 1 specimen, R.U.C., Lambert's Bay; 5 specimens, R.U.C., Bird Island, Port Elizabeth; 4 specimens, S.A.M. 25250, Froggy Pond, False Bay; 9 specimens (10-20 mm standard length), S.A.M. 25257 & S.M. 5269-5271, Möwe Bay, S.W.A.

Description: D. 5-6; A. 5-6; P. 21-22; C. 10-12. Gills three and one half. Third gill arch with six minute gill-rakers. Maximum depth of body 4.4-5.7 in standard length.

Head broad, depressed, 2.3-2.4 in standard length, maximum breadth of head 2.75-3.25 in standard length. Eye round, orbit diameter 4.5-6 in head. Interorbital width greater than orbit diameter, 3-3.7 in head. Snout a little longer than eye, rounded, 3-3.7 in head. Anterior nostril tubular, posterior nostril a simple pore. Mouth terminal, upper jaw 2.25-3.7 in head, breadth of mouth at posterior angles of jaw 2-2.8 in head. Teeth conical, caniniform; four distinctly compressed, enlarged, incisiform teeth in front of upper jaw of 25, 34 (both), 32, and 42 mm specimens.

Dorsal and anal fins in posterior fourth of body. Anus anterior to dorsal origin, slightly nearer to pectoral tip than to caudal base. Pelvic disc double, fringed with small branched papillae, disc length 2.9-3.8 in standard length. Caudal peduncle very short, 4.5-5.5 in head length, deeper than long, depth 3-3.7 in head length. Caudal fin rounded.

Colouring: Upper parts dark red to reddish brown in Rocky Point specimens and 34 mm Möwe Bay specimen, light green in 32 and 42 mm Möwe Bay specimens. Angolan specimen red with greenish mottling. A light bar across interorbital in the three largest specimens. Underparts of all specimens lighter, creamy buff. Throat with fine red spots in all except the 32 and 42 mm specimens. Pectoral fins hyaline; pelvic disc hyaline in most specimens, orange in 32 and 42 mm specimens. Dorsal, anal, and caudal fins barred with main colour of upper parts.

Habitat: Intertidal; the Rocky Point specimens were collected amongst mussels (*Perna perna* (Linnaeus)) and coralline algae in pools at the middle levels of the intertidal zone of the shore. The Möwe Bay specimens were collected under large stones in pools at the middle levels of the shore amongst brachiopods (*Disciniscus tenuis* (Sowerby)).

Distribution: Dakar, Senegal, to the Cape Verde, Canary, and Madeira Islands (Briggs, 1955); Annobón Island (Blanc, Cadenat & Stauch, 1968); Lambert's Bay to Port Elizabeth (Smith, 1964).

Remarks

Three species have been included in the genus *Apletodon* Briggs: *A. pellegrini*; *A. microcephalus* (Brook), from Sicily to Scotland (Briggs, 1955), with a sub-

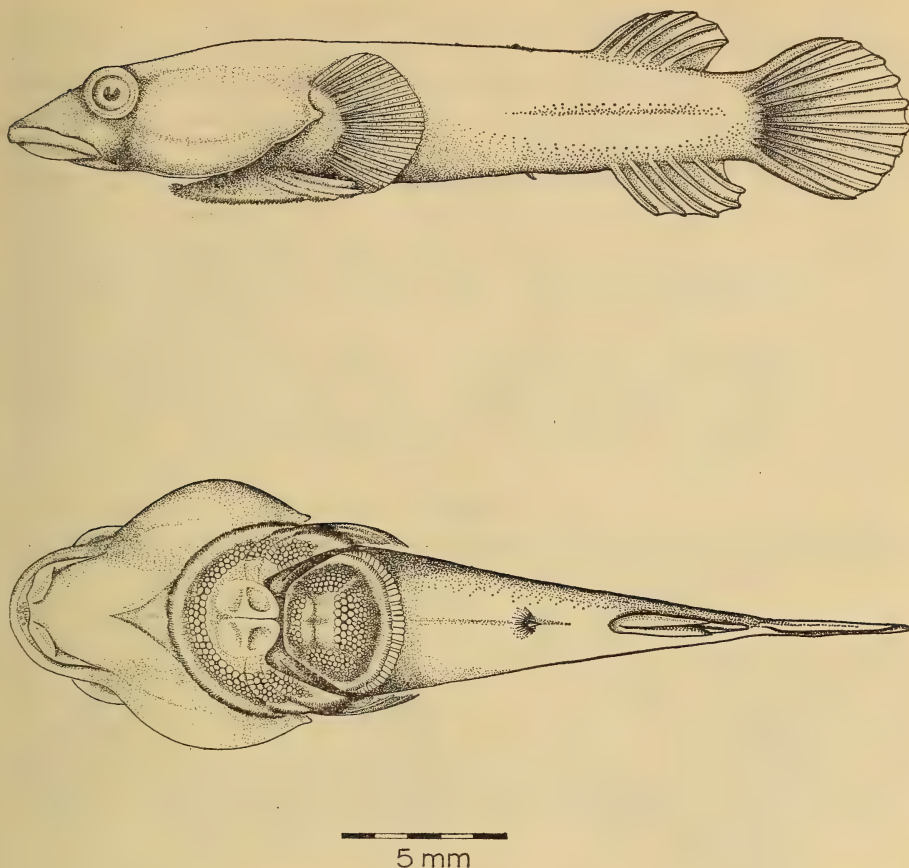


Fig. 2. *Apletodon pellegrini* (Chabanaud).

species *A. m. bacescui* Antoniu Murgoci from the Black Sea (Murgoci, 1964); and *A. knysnaensis* Smith, from the southern coast of South Africa from Lambert's Bay to Port Elizabeth (Smith, 1964).

Comparison of specimens of *A. pellegrini* and the typical form of *A. microcephalus* indicates that they are two clearly distinct species which differ in a number of features, the most marked difference being the considerably narrower head of *A. microcephalus*. *A. pellegrini* and *A. knysnaensis* are by no means as readily separable.

Smith (1964) distinguished *A. knysnaensis* from *A. pellegrini* chiefly on the length of the head in profile and the position of the anus with regard to the pectoral fin and the caudal base. He stated that *A. knysnaensis* was extremely similar to *A. pellegrini*, and that, but for the great distance separating the two forms geographically, he might be tempted to accord the southern form sub-specific status only.

I can find no difference between the South West African and Angolan specimens and specimens of *A. pellegrini* from the northern hemisphere and Annobón Island. Furthermore, comparison of the northern hemisphere, Angolan, and South West African specimens of *A. pellegrini* with specimens, including the types, of *A. knysnaensis*, indicates that these two species are in fact indistinguishable. The position of the anus with regard to the pectoral tip and the caudal base appears to vary, but in the majority of specimens (all the northern hemisphere, Annobón, and Angolan/South West African specimens and several of the southern ones) the anus was found to be slightly nearer the pectoral tip. As far as the profile head length is concerned, there is much overlap: measurements are given in table 1. Judging from the proportions given by Smith (1964), he may have made his measurements slightly differently from mine, but the difference between southern and northern forms is in any event so slight as not to warrant even subspecific separation.

TABLE I

Comparison of head lengths (profile) of *Apletodon pellegrini* from the northern hemisphere, Angola/South West Africa, and the southern coast of South Africa.

Locality	Standard length (mm)	Head length in standard length
Cap Blanc	25	2.3
Cap Blanc	29	2.2
Senegal	28	2.2
Senegal	20	2.2
Dakar	28	2.3
Dakar	20	2.5
Dakar	18	2.3
Moçamedes	29	2.4
Rocky Point	34	2.4
Rocky Point	25	2.3
Rocky Point	26	2.4
Rocky Point	22	2.4
Möwe Bay	42	2.3
Möwe Bay	34	2.4
Möwe Bay	32	2.3
Lambert's Bay	32	2.3
False Bay	25	2.3
False Bay	21	2.3
False Bay	20	2.5
False Bay	21	2.3
Knysna	33	2.4
Knysna	24	2.4
Knysna	32	2.5
Knysna	29	2.3
Knysna	34	2.4
Knysna	24	2.4
Knysna	23	2.7
Port Elizabeth	25	2.5
Port Elizabeth	23	2.6
Port Elizabeth	26	2.6
Port Elizabeth	25	2.8
Port Elizabeth	23	2.3

It seems then that there are two species of the genus *Apletodon*, one confined to the North Atlantic and Mediterranean region, and one widely distributed along the African coast, including offshore islands.

Chorisochismus dentex (Pallas, 1769)

(Fig. 3)

Cyclopterus dentex Pallas, 1769: 6, pl. 1.

Chorisochismus dentex: Günther, 1861: 490. Barnard, 1927: 423. Smith, 1949: 384, pl. 87 fig. 1086; 1964: 587, pl. 94 A, B. C. Briggs, 1955: 40 (synonymy and references).

Material: 7 specimens, 92–167 mm standard length, S.M. 4929–4934, intertidal pools, Rocky Point, S.W.A.; 6 specimens, 99–190 mm standard length, S.A.M. 25221, intertidal pools, Rocky Point, S.W.A.; 1 specimen, 115 mm standard length, S.M. 4405, intertidal pool, 42 miles north of Unjab River mouth, S.W.A.; 1 specimen, 133 mm standard length, S.A.M. 25228 intertidal pool, 42 miles north of Unjab River mouth; 1 specimen, 128 mm standard length, S.A.M. 25231, Honolulu, S.W.A.; 13 specimens, 11–115 mm standard length,

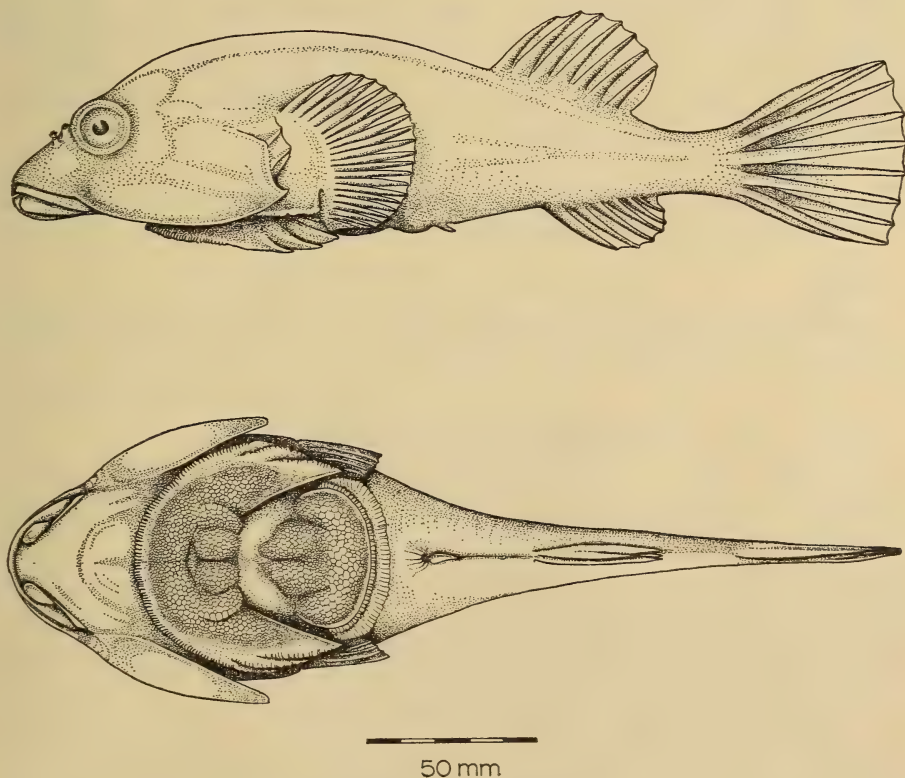


Fig. 3. *Chorisochismus dentex* (Pallas).

S.A.M. 24209, Lüderitzbucht, S.W.A.; 22 specimens, 11–84 mm standard length, S.A.M. 25248, Lüderitzbucht, S.W.A.

Description: D. 7–8; A. 6; P. 21–23; C. 9–10. Gills three and one half. Second gill arch with four minute gill-rakers. Maximum depth of body 3.2–4.1 in standard length in 84–190 mm specimens, 4.5–5.3 in standard length in smaller specimens.

Head broad, not strongly depressed, 1.9–2.5 in standard length, breadth of head about equal to, usually very slightly less than, length; 1.9–2.9 in standard length. Eye round, orbit diameter 3.2–4.9 in head. Interorbital width about equal to eye in large specimens, less in smaller specimens, 2.7–5.2 in head length. Snout a little longer than eye, bluntly rounded, 2.6–3.7 in head. Anterior and posterior nostrils tubular, anterior nostril with a simple expanded dermal flap on posterior rim. Mouth terminal, upper jaw 2.4–3.3 in head, breadth of mouth at posterior angles of jaws 1.4–3.2 in head, broadening with increase in standard length. Teeth mainly conical, enlarged, prominent, and slightly compressed in front.

Dorsal and anal fins in posterior third of body. Anus well anterior to dorsal origin. Urogenital papilla of male very much larger than that of female. Pelvic disc single, length 2.6–3.2 in standard length. Caudal fin subtruncate. Caudal peduncle 2.3–4.3 (3–4 in most specimens) in head length, longer than deep, depth 4.3–5.8 in head length.

Colouring: Very variable; most specimens pinkish or greenish mottled to match surroundings. Underparts creamy.

Habitat: Intertidal and infratidal; clings to rocks.

Distribution: Alexander Bay (South African Museum); Port Nolloth to northern Natal (Zululand) coast (Smith, 1964).

Remarks

This is the only species of clingfish that is common on South West African shores.

Eckloniaichthys scylliorhiniceps Smith, 1943

(Fig. 4)

Eckloniaichthys scylliorhiniceps Smith, 1943: 67, fig. 1; 1949: 384, pl. 87 fig. 1087; 1964: 584, pl. 92 D, pl. 93 D, E. Briggs, 1955: 72.

Material: 1 specimen, 15 mm standard length, S.A.M. 25249, intertidal pool, Agate Beach, Lüderitzbucht.

Description: D. 5; A. 5; P. 18; C. 10. Gills three. Each gill arch with four minute gill-rakers. Maximum depth of body 7.5 in standard length.

Head depressed, 3.0 in standard length, maximum breadth of head 5.0 in standard length. Eye round, orbit diameter 5.0 in head. Interorbital width equal to orbit diameter. Snout twice length of eye, narrowly rounded, 2.5 in head. Mouth subterminal, inferior, upper jaw 5.0 in head, width of mouth at

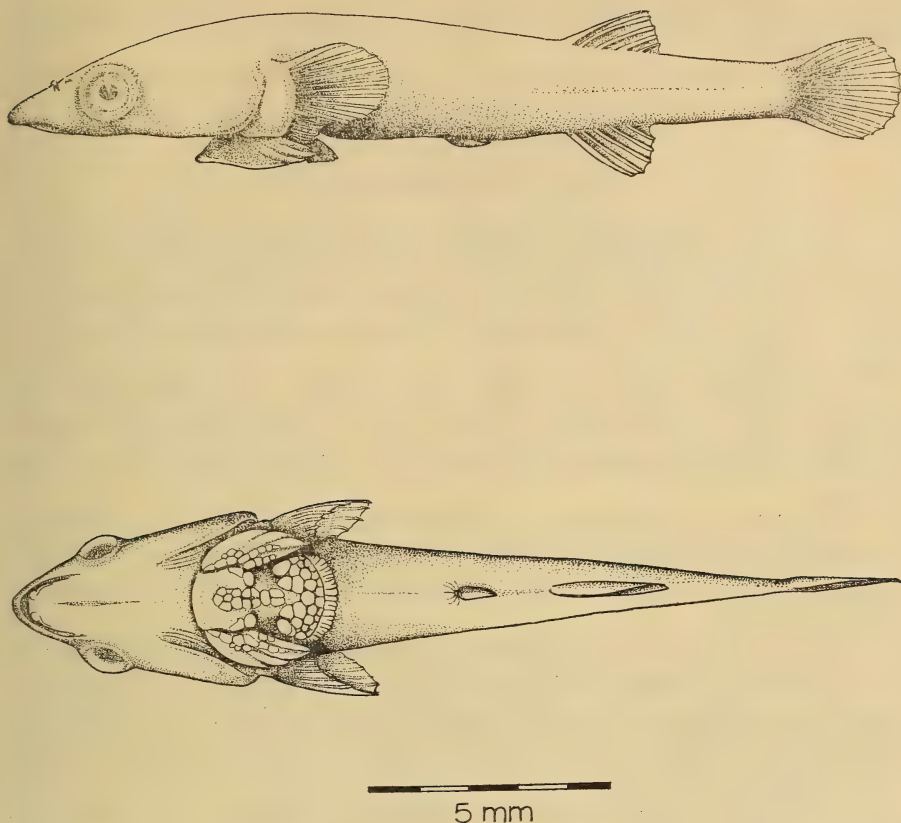


Fig. 4. *Eckloniaichthys scylliorhiniceps* Smith.

posterior angles of jaws 5.0 in head. Teeth minute, bluntly conical in upper jaw, lower jaw with six blunt incisiform teeth at front of jaw, followed by three caniniform teeth on either side.

Dorsal and anal fins in posterior fourth of body. Anus in front of dorsal origin. A flat fleshy pad on lower part of pectoral base. Pelvic disc single, length 5.0 in standard length. Caudal peduncle 1.7 in head length, much longer than deep, depth 5.0 in head length. Caudal fin rounded.

Colouring: Upper parts plain dark olive brown, lower parts creamy.

Habitat: Clinging to kelp stipe in intertidal gully.

Distribution: Sea Point (west coast of Cape Peninsula) (South African Museum); False Bay to East London (Smith, 1964); Kei River mouth (South African Museum).

Remarks

This small, rather rare clingfish is always found attached to algae. On the west coast, where it has been found only on kelp (*Ecklonia* and *Laminaria*), it

is brown; from False Bay eastwards it usually occurs on *Caulerpa*, and is then bright green.

The Lüderitzbucht specimen is a female; males of this species are easily distinguished by the very large urogenital papilla.

REMARKS ON DISTRIBUTION

The known distribution of the three species of clingfishes recorded from South West Africa is shown in figure 5. Two of the species, *Chorisochismus dentex* and *Eckloniaichthys scylliorhiniceps*, appear to be endemic to the southern African region, while the third is very widely distributed from northern West Africa to southern Africa.

Chorisochismus dentex is the only really common intertidally occurring clingfish on the southern African coast. It is one of the few endemic southern African intertidal fish species that extend to the northern coast of South West Africa.

Eckloniaichthys scylliorhiniceps is known from relatively few specimens, probably mainly because it is a minute and very cryptic species and its habitat is difficult to sample. Both it and *Apletodon pellegrini* are likely to be found at further localities.

At the present state of knowledge, there are several considerable gaps in the distribution of *Apletodon pellegrini*, the greatest of which are the stretches of coast between Dakar and Annobón Island, Annobón Island and Moçamedes, and Rocky Point and Lambert's Bay. Considering that these fishes are small and inconspicuous, and the intertidal zone of the shore in tropical West Africa is poorly known, at least some of these gaps may be apparent rather than real. However, Rocky Point and Lambert's Bay both lie in transitional areas where, owing to changing hydrographic conditions, overlap of different faunal provinces occurs. Between them is the stretch of coast where very low temperatures prevail owing to the Benguela upwelling system; if *Apletodon pellegrini* really is absent from this region, its absence may be related to hydrographic conditions.

SUMMARY

Three species of clingfishes are recorded from South West Africa, a region from which no clingfishes were previously known. In the light of the South West African material, a southern African species is synonymised with a species from northern West Africa. The South West African material is described, and the distribution of the three species is briefly discussed.

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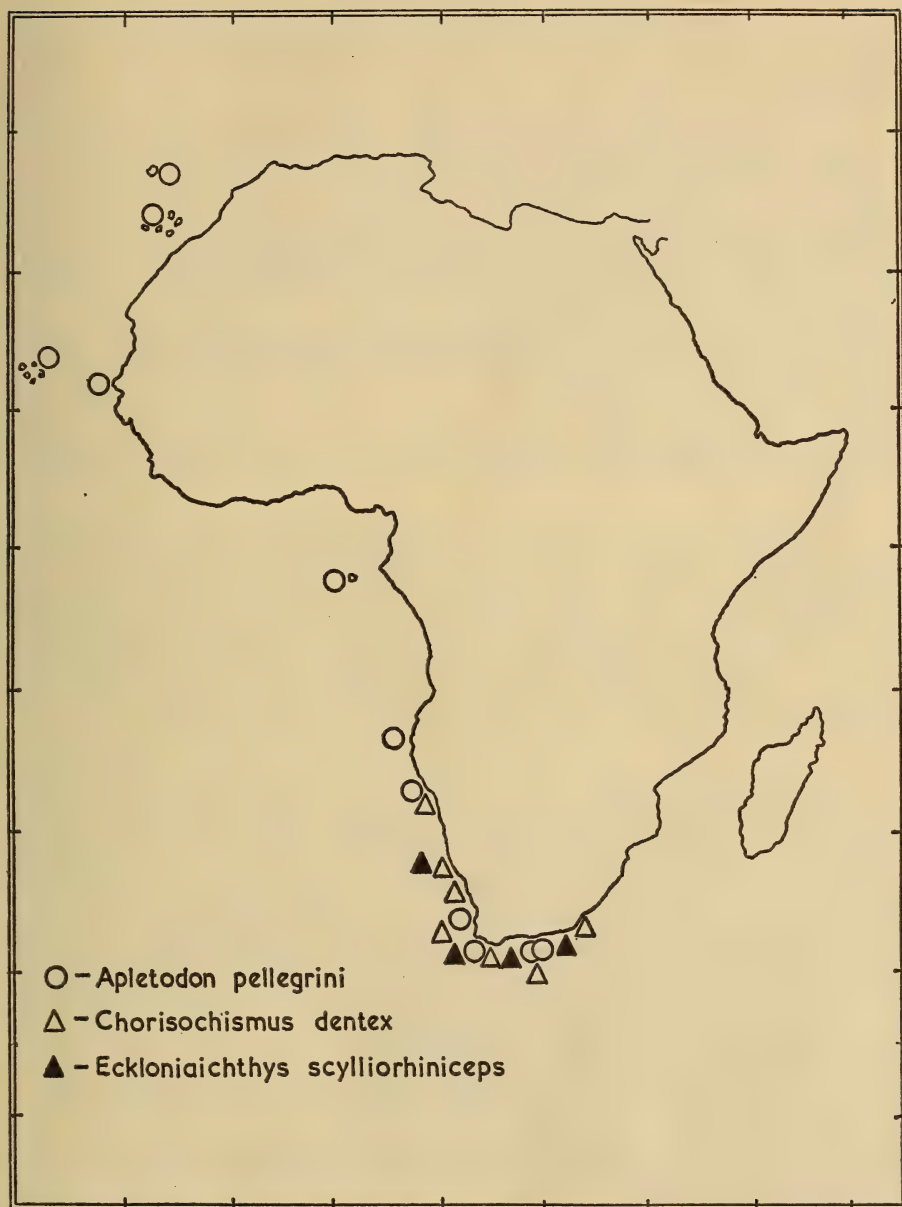


Fig. 5. Distribution of *Apletodon pellegrini*, *Chorisochismus dentex* and *Eckloniaichthys scylliorhiniceps*.

West Africa and Angola. I am indebted to the South West African Administration, and in particular Mr. C. G. Coetzee, Director of the State Museum, Windhoek, for making it possible for me to visit the northern coast of South West Africa.

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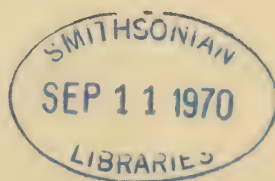


THE DISTRIBUTION OF THE FISHES OF THE
FAMILY CLINIDAE IN SOUTHERN AFRICA

By

MARY-LOUISE PENRITH

Cape Town Kaapstad



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South African Museum, Cape Town

(With 5 figures)

[MS. received 20 October 1969]

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INTRODUCTION

Thirty-five species of the family Clinidae are known from the coast of Africa. Two of them belong to the subfamily Labrisominae and these are restricted to tropical West Africa. The remaining 33 all belong to the tribe Clinini of the subfamily Clininae (Hubbs, 1952; Penrith, 1969), and all are endemic to southern Africa between the Kunene River on the west coast and Inhambane in Moçambique. In spite of intensive collecting by the late Professor J. L. B. Smith in tropical East Africa, no clinids have been recorded from the east coast north of Inhambane.

The distribution of the dominant elements of the intertidal fauna and flora of South Africa was described by the late Professor T. A. Stephenson and his colleagues before the Second World War, and the main conclusions are summarized in three papers (Stephenson, 1939, 1944, 1948). These conclusions were not based on shore fishes, which are difficult to catch, but Stephenson (1948) noted that the distribution of the Clinidae outlined by Smith (1945) agreed closely with the distribution of other shore animals. Stephenson further suggested that, since the clinids dealt with by Smith are all endemic, the details of their distribution would be particularly interesting. This stimulated

the present study, and the data obtained have provided new evidence to test Stephenson's conclusions regarding the limits of the faunistic provinces around southern Africa.

In broad outline it may be said that the clinids are the dominant group of fishes that live permanently on the shores of the Cape Province and southern South West Africa. Further north along the shores of South West Africa the clinids are largely replaced by other families of shore fishes, and this is also true on the coasts of Natal and Moçambique. Around the Cape, from Lüderitzbucht in southern South West Africa, to the Transkei, where clinids predominate, there are changes in species composition and abundance that are similar to the changes in other intertidal animals.

METHODS

Many collecting trips to various parts of the coast between Moçamedes in southern Angola and Durban have been carried out by the South African Museum since 1963. An outline of the southern African coast with the localities where collections were made is shown in figure 1. Where possible, localities were visited more than once. The records obtained from these field trips, both with regard to occurrence and abundance of species, form the basis of the present work. In addition, records supported by identified specimens in the collections of the South African Museum, the J. L. B. Smith Institute of Ichthyology (formerly Department of Ichthyology), Rhodes University, Grahamstown, and the Zoology Department, University of Cape Town, have been used. Finally, certain individuals have made collections in particular areas on behalf of the South African Museum; these are acknowledged below.

NOTE ON THE STABILITY OF SOUTH AFRICAN CLINID POPULATIONS

Many fishes, even ones which are permanent inhabitants of the intertidal region of the shore, are unsuitable subjects on which to base conclusions regarding faunal distribution boundaries, owing to their mobility. Many intertidal fishes show seasonal variation in distribution (Dr. V. G. Springer, personal communication). However, the South African Clinidae appear to be an extremely sedentary group of fishes, forming a highly stable intertidal population. Collecting in all months of the year over a period of more than four years on both east and west coasts of the Cape Peninsula produced no evidence for any kind of seasonal variation in either the occurrence or the proportions of the different species making up the clinid population.

There seems to be little reason for the Clinidae to show seasonal variation in their occurrence on South African shores. Conditions of temperature, at least, normally one of the strongest factors influencing seasonal variation, tend to vary relatively little at any given locality on the South African coast. A series of maximal and minimal monthly mean surface temperatures for localities

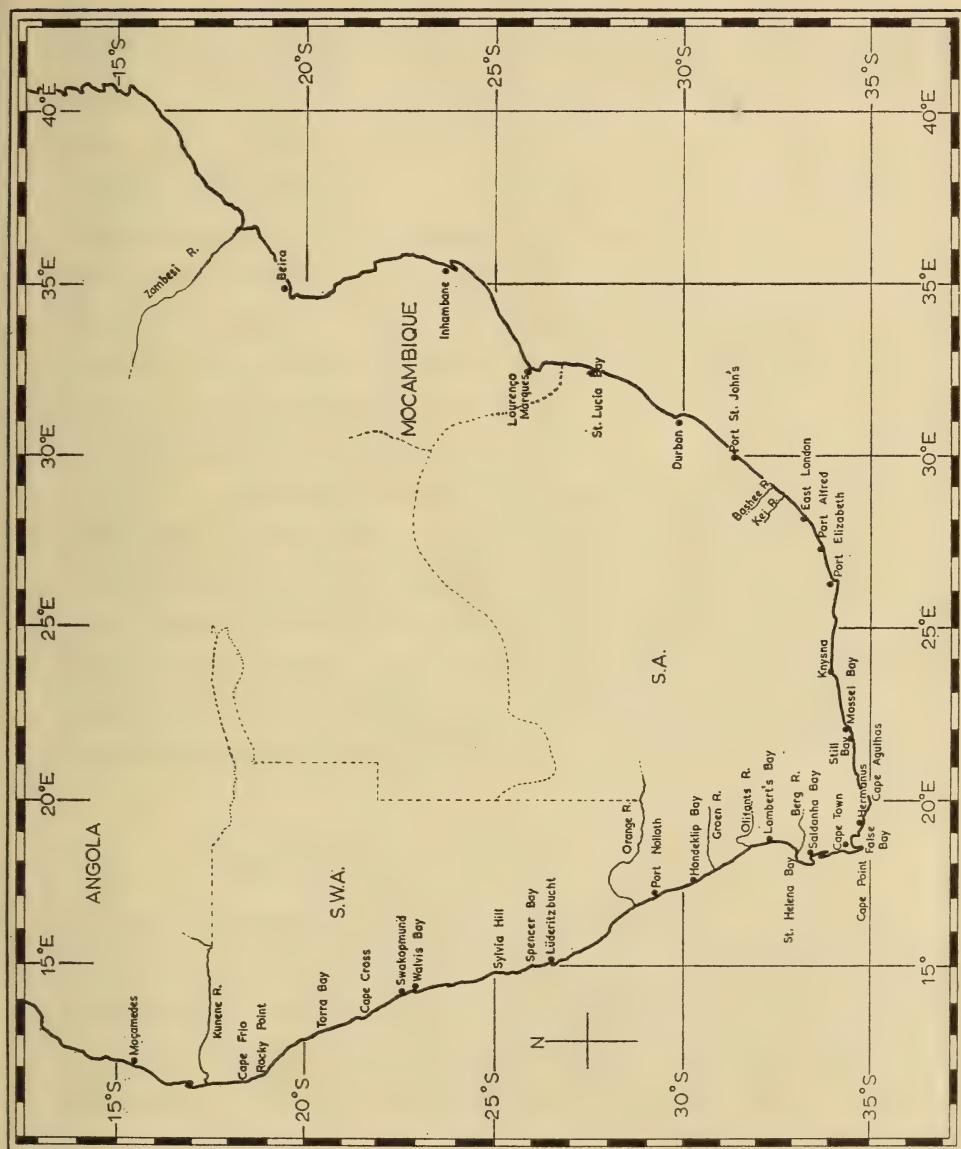


Fig. 1. Coastline of southern Africa showing localities at which collections were made.

from Saldanha Bay to Durban given by Isaac (1937) show differences of rarely more than 6.5°C between maxima and minima, and frequently less. From data given by Marchand (1932), Buys (1957) and Division of Sea Fisheries annual reports (1963, 1964) the same appears to be true of localities north-west of Saldanha Bay. These fluctuations are smaller than would occur in the intertidal zone from day to night, and would not be expected to affect intertidal animals.

Furthermore, the habits of the South African Clinidae make it unlikely that populations would move about freely. Seasonal mobility is often related to breeding. All the South African Clinidae bear their young alive, fertilization being internal. Mature females of several common species (*Clinus acuminatus*, *C. cottoides*, *C. superciliosus*, *Blennioclinus brachycephalus* and *Pavoclinus mus*) from one or two localities in False Bay, showed eggs and embryos in several stages of development in all or almost all months of the year. From this it appears that there is no fixed breeding season. Preliminary observations in an aquarium tank indicated that raised temperature produces increased sexual activity in *Clinus acuminatus* at least, but the degree of solar warming of intertidal pools during periods of low tide is probably the determining factor here. Clinidae have been observed mating in a tidal pool in False Bay on warm sunny days in winter, when general sea temperatures in the area were low.

Another factor restricting the mobility of Clinidae may be territoriality. Gilchrist & Thompson (1911) observed territorial behaviour in Clinidae both in the field and in an aquarium. A further indication that territoriality exists is the fact that a pool which has been more or less cleared of fishes by rotenone poisoning will remain unoccupied for periods of six to eight months, although the effects of the poison disappear with the first high tide, and then occupation will be by small, maturing fishes. It seems, therefore, that the South African Clinidae may be considered as reliable as any animal in indicating boundaries to faunal distribution.

SOUTH AFRICAN INTERTIDAL FAUNAL PROVINCES

On the basis of a series of detailed surveys of rocky intertidal shores at a number of localities from Port Nolloth to Durban, Stephenson (1944, 1948) recognized three faunal provinces in the South African intertidal zone: the west coast, from the Orange River to Cape Point; the south coast, from Cape Point to the region of Qolora/Port St. John's; the east coast, from Port St. John's to northern Natal. The areas between Kommetjie, on the west coast of the Cape Peninsula, and Cape Agulhas, and between Port Elizabeth and Port Edward, showed a marked overlap between faunal provinces. Ekman (1953) followed closely Stephenson's conclusions regarding the South African faunal provinces, placing the boundary between the south and south-west ('Namaqua') faunas in the region of the Cape of Good Hope, and the southern boundary of the tropical south-east African fauna south-west of Durban. The position of this latter boundary is not clear, but Ekman suggested that Algoa Bay might

constitute the southern boundary of distribution of a subtropical fauna extending from there to the area of Durban. Ekman recognized the area from Algoa Bay to Cape Agulhas/Cape Point as an independent zoogeographical province, and followed Stephenson (1944, 1948) in treating it as warm-temperate, although he pointed out that according to the temperature divisions he used it was subtropical rather than temperate. On the west coast, Ekman placed the northern boundary of the 'Namaqua' faunal province in the region of Cape Frio.

Knox (1960), discussing the biogeography of the southern oceans, gave a division of South Africa into a cold-temperate 'West African Province', extending from the Cape Peninsula to about 18°S (i.e. the region of Cape Frio), and a warm-temperate 'Cape Province'. Surveys made on the coast of South West Africa, north of the Orange River, show that the west coast province extends at least as far north as Lüderitzbucht, but that further north the intertidal fauna of rocky shores is of a different nature (Penrith & Kensley, in press). The northern boundary of the west coast province lies somewhere between Lüderitzbucht and Walvis Bay.

The three faunal provinces proposed by Stephenson are closely related to temperature conditions around the South African coast. Owing to the Benguela upwelling system, the water of the west coast is cold, inshore surface temperatures on the open coast seldom rising above 15°C between Cape Point and Lüderitzbucht (Marchand, 1932; Isaac, 1937). From Walvis Bay northwards warmer inshore surface temperatures (16–18°C in summer) are encountered (Stander, 1964). The south coast east of Cape Point is warmer than the west coast, with monthly mean inshore temperatures of 15–20°C (Marchand, 1932; Isaac, 1937; Stephenson, Stephenson & Du Toit, 1936). The east coast is subtropical in character; Marchand (1932) found monthly mean temperatures inshore varying from 18 to 24°C.

Day (1967), discussing the distribution of polychaete worms around southern Africa, considered that the west and south coast faunal provinces are not distinct if the regions below the intertidal zone are considered as well. This is probably because offshore bottom temperatures are more uniform east and west of Cape Point (Day, 1967). Day noted that many of the differences between the west and east coast faunal provinces are of relative abundance rather than of occurrence. Apart from such differences in relative abundance, there are many similarities between the west and south coast faunas; each shows a high degree of endemism, about 45% of the species occurring there being endemic (Day, 1967). Numerous species are common to both coasts.

DISTRIBUTION OF THE SOUTH AFRICAN CLINIDAE

Of the 33 species of South African Clinidae, 30 belong to the subtribe Clinidi, and the following discussion will be concerned with these species. The other three species, belonging to the subtribe Xenopoclinidi, are specia-

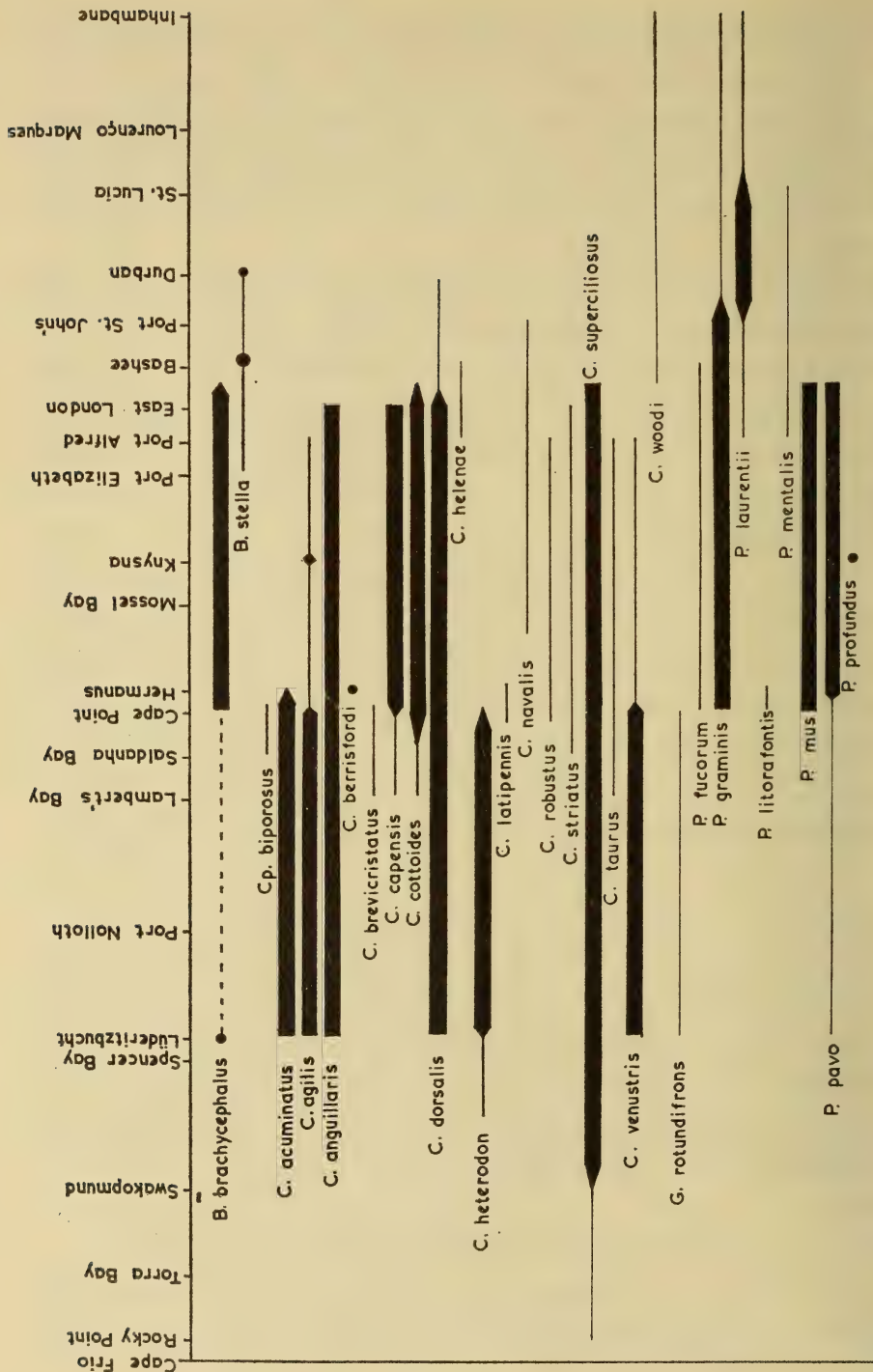


Fig. 2. Distribution of the South African species of Clinidi. Thickened lines indicate ranges over which species are regularly present to common.

lized sand-burrowers which have been found intertidally only in the Lambert's Bay area, and I consider their distribution too imperfectly known to be discussed further here.

Nine of the 30 species of Clinidi occur both inter- and infratidally, larger specimens in general being taken in deeper water; 14 have been taken more or less exclusively intertidally, and seven occur mainly infratidally, although juvenile and even adult specimens may occur intertidally from time to time in most cases; *Clinus woodi* occurs intertidally in the northern part of its range, but is infratidal further south (Mrs. M. M. Smith, personal communication). The species in these three categories are listed for reference in table 1.

The known ranges of distribution of the 30 South African species of Clinidi are shown in figure 2. Most of the species occur between Lüderitzbucht and the Kei River mouth; this is shown in a graph illustrating the number of species recorded from different localities along the coast (fig. 3). Two of the species, *Clinus berrisfordi* and *Pavoclinus profundus*, are known only from their single type localities. Of the remaining 28, 14 are common, fairly common, or at least regularly present over part or the whole of their known ranges of distri-

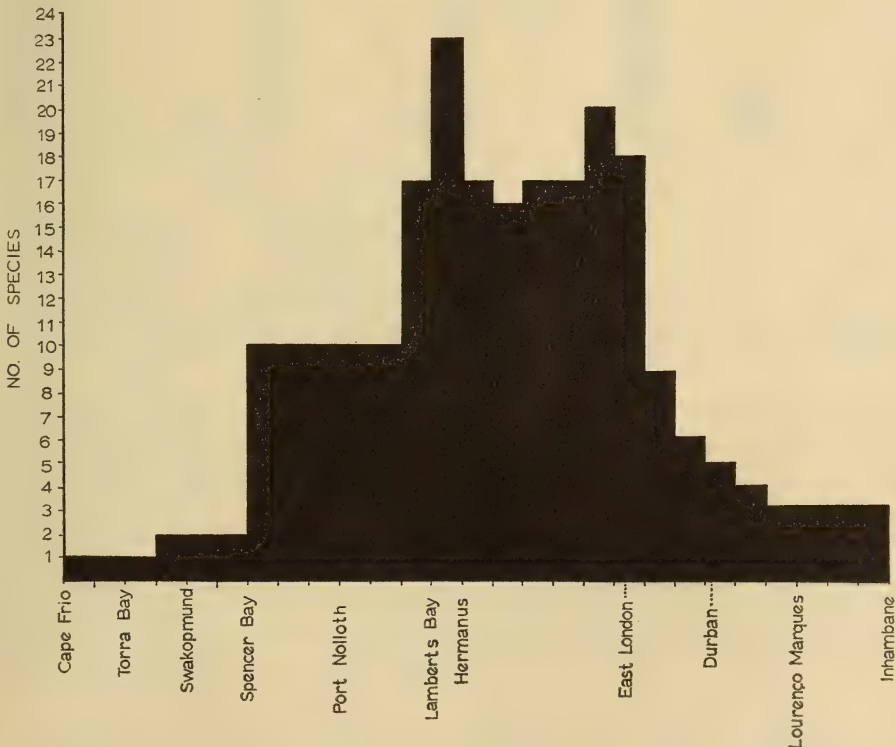


Fig. 3. Number of species of Clinidi present along each stretch of coast of approximately 100 miles, from Cape Frio to Inhambane.

bution (indicated by thickened lines in figure 2); three are, at most, regularly present in particular and limited habitats, and 11 are apparently rare (table 2). It may be noted that all the mainly infratidal species fall in the categories of less frequent occurrence, and this picture might change if sampling of the infratidal region down to about 30 metres depth were more effective.

TABLE 1

Inter- & Infratidal	Mainly intertidal	Mainly infratidal
<i>Clinus anguillaris</i>	<i>Clinus acuminatus</i>	<i>Clinoporus biporosus</i>
<i>Clinus capensis</i>	<i>Clinus agilis</i>	<i>Clinus robustus</i>
<i>Clinus striatus</i>	<i>Clinus berrisfordi</i>	<i>Clinus taurus</i>
<i>Clinus superciliosus</i>	<i>Clinus brevicristatus</i>	<i>Clinus woodi</i>
<i>Clinus venustis</i>	<i>Clinus cottoides</i>	<i>Gynutoclinus rotundifrons</i>
<i>Pavoclinus fucorum</i>	<i>Clinus dorsalis</i>	<i>Pavoclinus mentalis</i>
<i>Pavoclinus graminis</i>	<i>Clinus helenae</i>	<i>Pavoclinus profundus</i>
<i>Pavoclinus laurentii</i>	<i>Clinus heterodon</i>	
<i>Pavoclinus litorafontis</i>	<i>Clinus latipennis</i>	
	<i>Clinus navalis</i>	
	<i>Blennioclinus brachycephalus</i>	
	<i>Blennioclinus stella</i>	
	<i>Pavoclinus mus</i>	
	<i>Pavoclinus pavo</i>	

TABLE 2

Frequency of occurrence of South African Clinidi

Single record only	Rare/Little known	Regularly present in particular habitats of rare occurrence only	Common, fairly common or regularly present over part or whole range
<i>Clinus berrisfordi</i>	<i>Clinoporus biporosus</i>	<i>Blennioclinus stella</i>	<i>Blennioclinus brachycephalus</i>
<i>Pavoclinus profundus</i>	<i>Clinus helenae</i>	<i>Clinus brevicristatus</i>	<i>Clinus acuminatus</i>
	<i>Clinus latipennis</i>	<i>Pavoclinus litorafontis</i>	<i>Clinus agilis</i>
	<i>Clinus navalis</i>		<i>Clinus anguillaris</i>
	<i>Clinus robustus</i>		<i>Clinus capensis</i>
	<i>Clinus striatus</i>		<i>Clinus cottoides</i>
	<i>Clinus taurus</i>		<i>Clinus dorsalis</i>
	* <i>Clinus woodi</i>		<i>Clinus heterodon</i>
	<i>Gynutoclinus rotundifrons</i>		<i>Clinus superciliosus</i>
	<i>Pavoclinus fucorum</i>		<i>Clinus venustis</i>
	<i>Pavoclinus mentalis</i>		<i>Pavoclinus graminis</i>
			<i>Pavoclinus laurentii</i>
			<i>Pavoclinus mus</i>
			<i>Pavoclinus pavo</i>

*This species is said to occur in fair numbers (Mrs. M. M. Smith, personal communication) but is not easily accessible for collecting over some of the range and the range over which it is common is consequently not known.

The extreme limits of distributional ranges of species are seldom fixed and reliable; most species dwindle in numbers towards the ends of their ranges, and as it is impossible to sample an area completely, the most easterly and westerly members of a species may never be caught. It is not easy, however, to be mistaken about whether a species is common in a given area or not. In attempting to pinpoint areas where faunal changes occur, I have in the first instance considered the ranges over which 14 species were regularly present (i.e. an invariable constituent of the fauna) to common intertidally. Figure 4 shows the number of eastern and western limits of these ranges occurring on each approximately 100-mile stretch of coastline between Cape Frio and Inhambane.

From figure 4 it can be seen that 24 of the 28 range limits occur on the following stretches of coast: (1) 100 miles south from Spencer Bay; (2) 100 miles

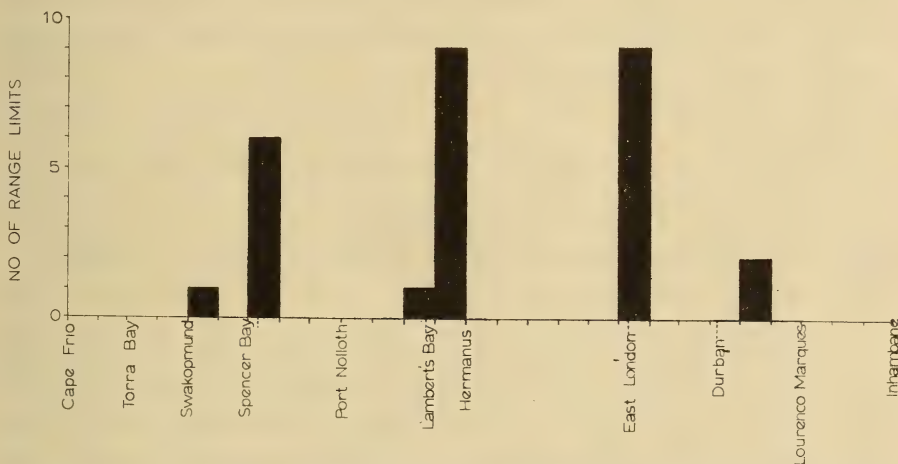


Fig. 4. Number of limits of ranges over which 14 species of Clinidi occur as regularly present to common along stretches of coast of approximately 100 miles between Cape Frio and Inhambane.

west from Hermanus; (3) 100-mile stretch in the vicinity of East London/Kei River mouth/Bashee River mouth. One of the remaining limits occurs immediately adjacent to (2), and the other three lie west and east of Spencer Bay or East London/Bashee River respectively.

It is evident that major changes in the nature of the clinid fauna occur in two of the areas (Cape Point/Cape Agulhas and East London/Bashee River) suggested as faunal province boundaries by Stephenson, and that a third major change occurs in the vicinity of Lüderitzbucht. The clinid faunas of the different intertidal provinces can now be considered.

1. The coast north of Lüderitzbucht

Only one species of clinid, *Clinus superciliosus*, occurs at all commonly north of Lüderitzbucht. It was fairly common at Sylvia Hill, Walvis Bay and Swakop-

mund. Small numbers were collected at Torra Bay, Möwe Point and Rocky Point, where it was rare, two species of blennies (*Blennius cornutus* and *Blennius vandervekeni*), and the clingfish *Chorisochismus dentex* being the common fishes of the intertidal zone of northern South West Africa. Single specimens of *Clinus heterodon* have been collected at Swakopmund and Sylvia Hill.

2. The west coast (Lüderitzbucht to Cape Point)

Apart from a goby, *Coryphopterus nudiceps*, and a clingfish, *Chorisochismus dentex*, both of which are fairly common, all the common intertidal fishes of the west coast are Clinidae. The most abundant clinid of the intertidal zone in this area is *Clinus agilis*. *Clinus superciliosus* is very common at all levels of the intertidal zone and below. *Clinus acuminatus* is common and *Clinus dorsalis* fairly common in pools at the top of the intertidal zone, juveniles of the latter species occurring at lower levels as well. *Clinus anguillaris* and *Clinus venustis* are regularly present in small numbers in pools at the bottom of the intertidal zone, the former species occurring infratidally as well. Occasional specimens of *Pavoclinus pavo* and *Gynutoclinus rotundifrons* have been taken amongst algae.

From the region of Lambert's Bay southwards to Cape Point, the typical west coast clinid fauna described above is modified by the addition of typically south coast forms, notably *Clinus cottoides*, which is common from Lambert's Bay southwards but has not been taken north of the Olifants River mouth.

3. The south coast (Cape Point to Kei River mouth)

The south coast has a larger number of common intertidal fish species than the west coast, and again most of these are Clinidae. The gobies *Coryphopterus caffer* and *Ctenogobius saldanha* and the clingfish *Chorisochismus dentex* are also common, and from Knysna eastwards two blennies, *Blennius cornutus* and *Blennius steindachneri*, became fairly common.

Clinus cottoides is the most abundant intertidal species from Cape Point eastwards to East London. *Clinus superciliosus* is very common at all levels of the shore at least as far east as Port Elizabeth, decreasing in numbers in the East London area. *Clinus dorsalis* is fairly common at the top of the shore. *Clinus anguillaris* is regularly present in small numbers, and the closely related species *Clinus striatus* is occasionally found from Saldanha Bay eastwards. *Clinus capensis* is fairly common in pools at all levels of the shore, the adults being mainly infratidal. *Blennioclinus brachycephalus* is common in pools at the lowest levels of the shore. In weed-beds, particularly of the green alga *Caulerpa filiformis*, and in algal clumps in rock pools, the species *Pavoclinus mus*, *Pavoclinus graminis*, and *Pavoclinus pavo* are common, and *Pavoclinus fucorum* occurs more rarely.

Clinus agilis and *Clinus heterodon* decrease sharply in numbers east of Cape Point. The former occurs very rarely on the south coast as far as Port Alfred, and fair numbers have been found in the Knysna lagoon (Penrith, 1969). *Clinus heterodon* has not been recorded east of False Bay, where it is extremely

rare. *Clinus acuminatus* is fairly common in False Bay, but has not been recorded east of Hermanus, where it is rare. *Clinus venustis* is rare east of Cape Point, and is usually taken infratidally. *Clinus robustus* and *Clinus taurus*, both large, mainly infratidal species, occur on the south coast.

4. *The east coast, north-east of the Kei River mouth, to Inhambane*

As on the coast north of Walvis Bay, Clinidae do not form a major constituent of the intertidal fish fauna. *Pavoclinus laurentii* is fairly common as far north as Inhaca Island, Moçambique (Mrs. M. M. Smith, personal communication) and *Pavoclinus graminis* as far as Port St. John's. *Blennioclinus stella* was taken in fair numbers from a single locality in the vicinity of Durban, although it is not generally common. Most of the other species apparently disappear before Durban is reached. The common intertidal fishes of the east coast are blennies (mainly *Blennius steindachneri*, *Omobranchus banditus*, *Halmablennius striatamaculatus* and *Croaltus bifilum*) and gobies (particularly *Bathygobius fuscus*).

5. *The coast from Inhambane northwards*

No Clinidae have been recorded north of Inhambane.

DISCUSSION

As all the South African clinid species are endemic, it is not surprising that the majority of them occur in the west and south coast intertidal faunal provinces. Day (1967) pointed out that, as far as polychaete worms were concerned, the Cape/South West African province (i.e. the west and south coasts) is dominated by endemics. The Natal (east) coast has some endemics, but also a considerable number of species from other sources; to the north-west and north-east of these provinces are faunal provinces consisting mainly of West African and Indo-Pacific tropical species respectively. Almost all the intertidal fishes of the west and south coasts are endemic to the South African region, while from the Bashee River north-eastwards and from Swakopmund north-westwards the percentage of endemics is lower.

Within the South African region, the clinid faunas of the west, south, and east coasts show differences in species composition and in the abundance of species which occur in more than one intertidal faunal province.

From figure 2 it can be seen that the general pattern of distribution of South African Clinidi, as far as it is known, corresponds with the intertidal faunal provinces mentioned above. The 28 species of Clinidi known from more than a single locality fall, at the present state of knowledge of their distribution, into the following categories: (1) species characteristic of the south coast; (2) species characteristic of the west coast; (3) species characteristic of the east coast; (4) species characteristic of both west and south coasts; (5) species characteristic of both south and east coasts; (6) species apparently restricted to the south-west coast overlap; (7) species apparently restricted to the south-east

coast overlap. The 28 species are arranged in these categories in table 3 and figure 5.

TABLE 3
Distributional categories of South African Clinidi.

West coast 1	South coast 2	East coast 3	W. & S. coasts 4	S. & E. coasts 5	W/S overlap 6	E/S overlap 7
<i>Clinus acuminatus</i>	<i>Clinus capensis</i>	<i>Blennioclinus stella</i>	<i>Clinus anguillaris</i>	<i>Pavoclinus graminis</i>	<i>Clinoporus biporosus</i>	<i>Clinus helenae</i>
<i>Clinus agilis</i>	<i>Clinus cottoides</i>	<i>Pavoclinus laurentii</i>	<i>Clinus dorsalis</i>	<i>Clinus navalis</i>	<i>Clinus brevicristatus</i>	
<i>Clinus heterodon</i>	<i>Blennioclinus brachycephalus</i>	<i>Pavoclinus mentalis</i>	<i>Clinus superciliosus</i>		<i>Clinus latipennis</i>	
<i>Clinus venustis</i>	<i>Pavoclinus fucorum</i>	<i>Clinus woodi</i>			<i>Pavoclinus litorafontis</i>	
<i>Gymnotoclinus rotundifrons</i>	<i>Pavoclinus mus</i>					
	<i>Pavoclinus pavo</i>					
	<i>Clinus robustus</i>					
	<i>Clinus striatus</i>					
	<i>Clinus taurus</i>					

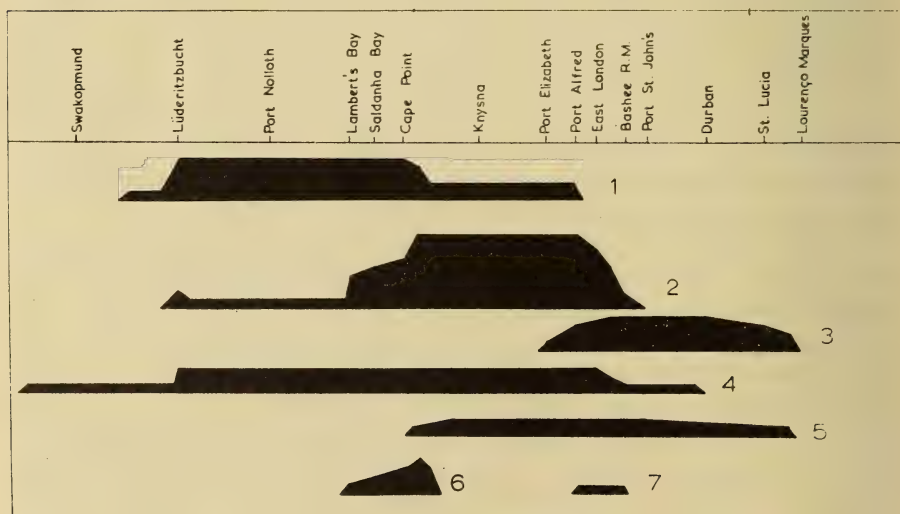


Fig. 5. Graphic representation of the various components of the South African Clinidi population. 1—west coast; 2—south coast; 3—east coast; 4—west and south coasts; 5—south and east coasts; 6—west/south coast overlap; 7—east/south coast overlap. (See table 3.)

All the species belonging to categories 6 and 7 are rare species, and these categories may be apparent rather than real.

Four species, *Clinus agilis*, *Clinus venustris*, *Blennioclinus brachycephalus* and *Pavoclinus pavo*, have been placed among the species characteristic of a single intertidal faunal province only, although the extremes of their recorded ranges of distribution encompass both west and south coast provinces. However, the change in incidence of these species in the region of Cape Point is so marked that they are here taken to be characteristic of only one intertidal faunal province. *Clinus agilis* and *Clinus venustris* were collected at all localities between Lüderitzbucht and Cape Point on the west coast but are extremely rare east of Cape Point. *Blennioclinus brachycephalus* has been recorded reliably from the west coast only at Lüderitzbucht, where small numbers were found in sheltered embayed areas. *Pavoclinus pavo* was collected at a few west coast localities, but is common from False Bay eastwards.

The fact that the distribution of the South African Clinidi corresponds closely with the South African intertidal faunal provinces, which are largely determined by temperature factors (Stephenson, 1948), suggests that South African clinid distribution is dependent on temperature. The effect of temperature on the distribution of a species may be twofold. Each species has a wider or narrower temperature range at which it can successfully exist, and its spread to areas outside this temperature range will be prevented by the direct effect of temperature. Secondly, other organisms which make a habitat suitable for a species may have a more limited temperature range, and their absence may prevent that species from spreading to areas not unsuitable from a point of view of temperature itself. Alternatively, a species may be prevented from spreading towards the ends of its possible temperature range by the intrusion of competitive species with overlapping temperature ranges.

Too little is known of the ecology of the South African Clinidi to estimate the importance of direct and indirect influence of temperature, or of other factors, in restricting their distribution. There are certain indications that at least both temperature effects probably operate.

Most of the clinid species do not appear to be strongly specific to a particular type of habitat. However, in spite of the fact that intertidal pools are not subject to the same conditions as the intertidal slopes that are exposed for varying lengths of time during periods of low tide, the Clinidi show vertical zonation comparable with that shown by other intertidal organisms (Stephenson, 1944, 1948). It has been pointed out by Day (1967) that the west and south coast faunal provinces are more sharply divided intertidally than infratidally, and that the faunas at least below 100 m are similar, as might be expected since at this depth temperatures east and west of Cape Point are uniform. In general, of the better known species, the more strictly intertidal ones (*Clinus acuminatus*, *Clinus agilis*, *Clinus cottoides*, *Clinus heterodon*, *Blennioclinus brachycephalus*, *Pavoclinus mus*, *Pavoclinus pavo*) are more restricted in at least their ranges of optimal occurrence than most of the species which occur infratidally as well

(*Clinus anguillaris*, *Clinus superciliosus*, *Pavoclinus graminis*). *Clinus dorsalis* is widely distributed and occupies a similar niche at the top of the intertidal zone to *Clinus acuminatus*, but, unlike *Clinus acuminatus*, occurs at all levels of the shore in the juvenile stages. This may protect the young from the extremes of solar heating to which the adults are subjected during periods of low tide. *Clinus venustis* shows a change in zonation east of Cape Point which is presumably the direct result of temperature, as it becomes infratidal as higher temperatures are encountered. *Clinus capensis*, with a similar habitat to *Clinus anguillaris*, is less widely distributed; other largely infratidal species, *Clinus robustus*, *Clinus striatus*, *Clinus taurus*, and *Clinus woodi*, also appear to have restricted distributions. Unfortunately, the greatest depths at which these species occur are not known. *Clinus superciliosus* has been taken from depths of 60 metres.

A possible instance of dependence on another organism is shown by *Clinus cottoides*. This species is abundant in midtidal pools, in the zone characterized on the south coast by a dense belt of barnacles (Stephenson, 1948). This balanoid zone is scarcely developed on the west coast, especially north of Lambert's Bay (Bright, 1938; Stephenson, Stephenson & Day, 1940). Barnacle legs form an important constituent of the diet of *Clinus cottoides*, and it is possible that this species avoids areas lacking barnacles.

Gynutoclinus rotundifrons and the species of the genus *Pavoclinus* are specialized for living in algae. None of them are restricted to a particular alga, with the possible exception of *Gynutoclinus rotundifrons*, which has so far been taken only in kelp. However, of the species occurring on the south coast, *Pavoclinus pavo* and *Pavoclinus graminis* show a wider preference for beds of *Caulerpa filiformis*, which does not occur west of Cape Point (Simons, in Day, 1969), and is fairly characteristic of the south coast. *P. mus* has not been observed in infratidal *Caulerpa* beds at a depth of approximately 10 metres (M. J. Penrith, personal communication) and is probably intertidal.

Too little is known at present about the biology of South African intertidal fishes to estimate the effects of interspecific competition. Towards the western and eastern limits of the South African region the clinid fauna is replaced by other mainly tropical groups, and in these regions competition with other groups may occur.

SUMMARY

The distribution of the South African fishes belonging to the subtribe Clinidi (Pisces: Clinidae) is discussed. All the species are endemic to the South African region (Kunene River to Inhambane), but within this region the distribution of the species is not uniform. It is, as far as can be determined at present, related to water temperatures, and agrees with the distribution patterns of other groups of intertidal animals. Factors such as habitat, food preferences, and competition might influence the distribution of individual species, the influence of temperature in these cases being indirect.

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Example

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07.68

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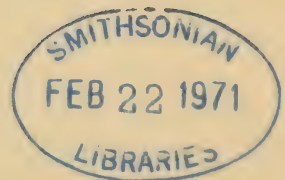
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AN INVESTIGATION OF THE RAJIDAE
OF THE WEST AND SOUTH COASTS
OF SOUTHERN AFRICA

By
P. A. HULLEY

Cape Town Kaapstad



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P. A. HULLEY

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(With 13 plates, 21 figures and 19 tables)

[MS. received 20 November 1969]

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INTRODUCTION

This paper represents the results of a three-year survey of the Rajidae of the west and south coasts of southern Africa, and is intended as a paper accompanying that of Wallace (1967) on the batoid fishes of the east coast of southern Africa. All known species of southern African Rajidae have been included in the given key, but, for descriptions of species which are exclusively east coast in distribution, Wallace's (1967) publication should be consulted.

The area originally covered by the survey extends from about Swakopmund on the west coast of South West Africa to Port Elizabeth on the south-east coast of the Republic of South Africa. The majority of the specimens have been obtained by commercial trawlers fishing on the continental shelf between 250 and 900 metres with otter trawls, while the rest have been taken at shallower depths by research vessels. The area of survey has been extended northwards along the west coast to 09°40'S by the examination of material taken by R. V. *Walther Herwig* in 1967. The results of this cruise are given in table 1.

The classification of South African skates is more or less tentative, for members of this difficult family show great variability in their morphological characters, which vary with age and/or sex in the individuals within a species. Furthermore, some of the type specimens of South African rajids, obtained by the Government Marine Survey at the beginning of this century, have been lost, so that it is difficult to verify original descriptions, especially where these are based on juvenile specimens. It is not surprising, therefore, that skate taxonomy has received casual treatment from South African systematists. Recently, however, Wallace (1967) has revised the east coast species, while

Hulley (1966, 1969) has shown that several species are identical with European species from the corresponding latitudinal belt in the northern hemisphere, and represent cases of bipolar distribution (Ekman, 1953).

Leigh-Sharpe (1920-6) has suggested the formation of pseudo-genera within the Rajidae based on clasper structure, but detailed descriptions of the anatomy of these organs in South African skates and their taxonomic significance above the species level will be published in the near future.

Although precaudal vertebral counts appear to be of greater value for separation of the family above the species level (Ishiyama, 1952), the external and internal structures of the clasper glans are species specific without exception (Ishiyama, 1958, 1967; Hubbs & Ishiyama, 1968) and may be used for comparison of geographically separated species (Hulley, 1966).

Zoogeographical and depth distributional patterns for the species are to be dealt with in a later paper; in the interim period, however, some idea of this may be obtained from the lists of material.

TABLE 1. Rajidae taken by R.V. *Walther Herwig* off the west coast of southern Africa in 1967.

Station No. WH /67	Position	Depth m	Species	No. of Specimens
6	09°40'S, 12°58'E	100	<i>R. miraletus</i> Linnaeus	6
10	10°28'S, 13°02'E	700	<i>R. straeleni</i> Poll	1
12	10°41'S, 13°29'E	100	<i>R. miraletus</i> Linnaeus	4
14	11°04'S, 13°30'E	440	<i>R. miraletus</i> Linnaeus	2
15	11°30'S, 13°25'E	110	<i>R. miraletus</i> Linnaeus	4
17	16°14'S, 11°33'E	100-120	<i>R. miraletus</i> Linnaeus	7
18	18°30'S, 11°27'E	310	<i>R. straeleni</i> Poll	1
			<i>R. miraletus</i> Linnaeus	2
19	18°35'S, 11°25'E	400	<i>R. straeleni</i> Poll	4
20	18°45'S, 11°20'E	500	<i>R. leopardus</i> Von Bonde & Swart	2
			<i>R. confundens</i> n.sp.	2
			<i>R. doutrei</i> Cadenat	1
32	20°25'S, 12°02'E	500	<i>R. leopardus</i> Von Bonde & Swart	1
			<i>R. confundens</i> n.sp.	1
			<i>R. doutrei</i> Cadenat	1
33	22°03'S, 13°12'E	200	<i>R. leopardus</i> Von Bonde & Swart	1
			<i>R. confundens</i> n.sp.	1
			<i>R. straeleni</i> Poll	2
37	22°15'S, 12°46'E	500	<i>R. leopardus</i> Von Bonde & Swart	1
			<i>R. confundens</i> n.sp.	1
43	23°00'S, 13°02'E	400	<i>R. confundens</i> n.sp.	2
77	30°02'S, 14°39'E	510	<i>R. confundens</i> n.sp.	2
			<i>R. caudaspinosa</i> Von Bonde & Swart	1
89	32°06'S, 16°22'E	400	<i>R. clavata</i> Linnaeus	1
100	34°12'S, 17°34'E	630	<i>B. smithii</i> (Müller & Henle)	1
126	27°13'S, 14°31'E	320	<i>R. confundens</i> n.sp.	1
161	26°25'S, 14°18'E	300	<i>R. clavata</i> Linnaeus	1
178	32°39'S, 17°25'E	245	<i>R. clavata</i> Linnaeus	1
			<i>C. parcomaculata</i> (Von Bonde & Swart)	2
194	33°47'S, 17°14'E	1 000	<i>R. dissimilis</i> n.sp.	3
			<i>R. ravidula</i> n.sp.	2
195	33°49'S, 17°13'E	1 000	<i>R. spinacidermis</i> Barnard	1
			<i>R. ravidula</i> n.sp.	1
196	33°51'S, 17°14'E	1 350	<i>R. spinacidermis</i> Barnard	1
			<i>R. robertsi</i> n.sp.	1

METHOD

Standard procedures in morphometry have been followed in this paper, and to interpret the variations in the proportional dimensions which take place during growth and which exist between the sexes, as many specimens as possible from each of the species have been examined and measured. As a check against the high intraspecific variability shown by rajids, counts of the number of precaudal vertebrae have been made and, where possible, the morphological structures of the claspers of adult males have been examined. For each species, figures of the external morphology of the clasper glans have been given.

In order to conform with previous work, the scheme of measurement which has been adopted in this paper is that of Bigelow & Schroeder (1953), and is represented diagrammatically in figure 1. Measurements of each specimen have been recorded to the nearest millimetre and have been calculated as permillage (thousandths) of the total length of the specimen. For a given species, the mean of each particular measurement has been calculated and is expressed in tabular form, together with the range of variation of that measurement. In some cases, where few specimens were available, the proportional dimensions of each specimen are given.

It should be noted that Hubbs & Ishiyama (1968) have suggested that the disc width should be used as a basis for computing the proportional sizes of the body parts, since the growth of the tail is negatively allometric (heterogonic) and the tail is frequently damaged. However, this work has shown that a much wider variation for each measurement (except the disc length) is obtained when disc width is used, and the total length has therefore been employed as the basis of calculation in all cases.

There would appear to be differences used in the terminology of the structures of the clasper glans by Leigh-Sharpe (1920-6), by Ishiyama (1958) and by Ishiyama & Hubbs (1968). Stehmann (1969) has evaluated these, and the terminology used in this paper is mainly in accordance with his findings.

Vertebral counts were facilitated by the use of X-ray photography. The number of precaudal vertebrae (Vprd) has been taken as the number of caudal vertebrae up to the origin of the first dorsal fin (Ishiyama, 1952; Krefft, 1968a); the number of trunk vertebrae (Vtr) and total count (VΣ) are given according to Krefft (1968a).

Although Bigelow & Schroeder (1953) have employed X-ray photography in examinations of the snout, this method has not been used in the present study, because of the small extent of calcification of the rostral cartilages (Ishiyama & Hubbs, 1968). The rostral cartilages and rostral appendices were examined by dissection.

SYSTEMATIC DISCUSSION

Family **Rajidae**

Flat, depressed head and body, forming a rhomboidal disc. Eyes prominent, rising above level of head; spiracles close behind eyes. Tail moderately slender,

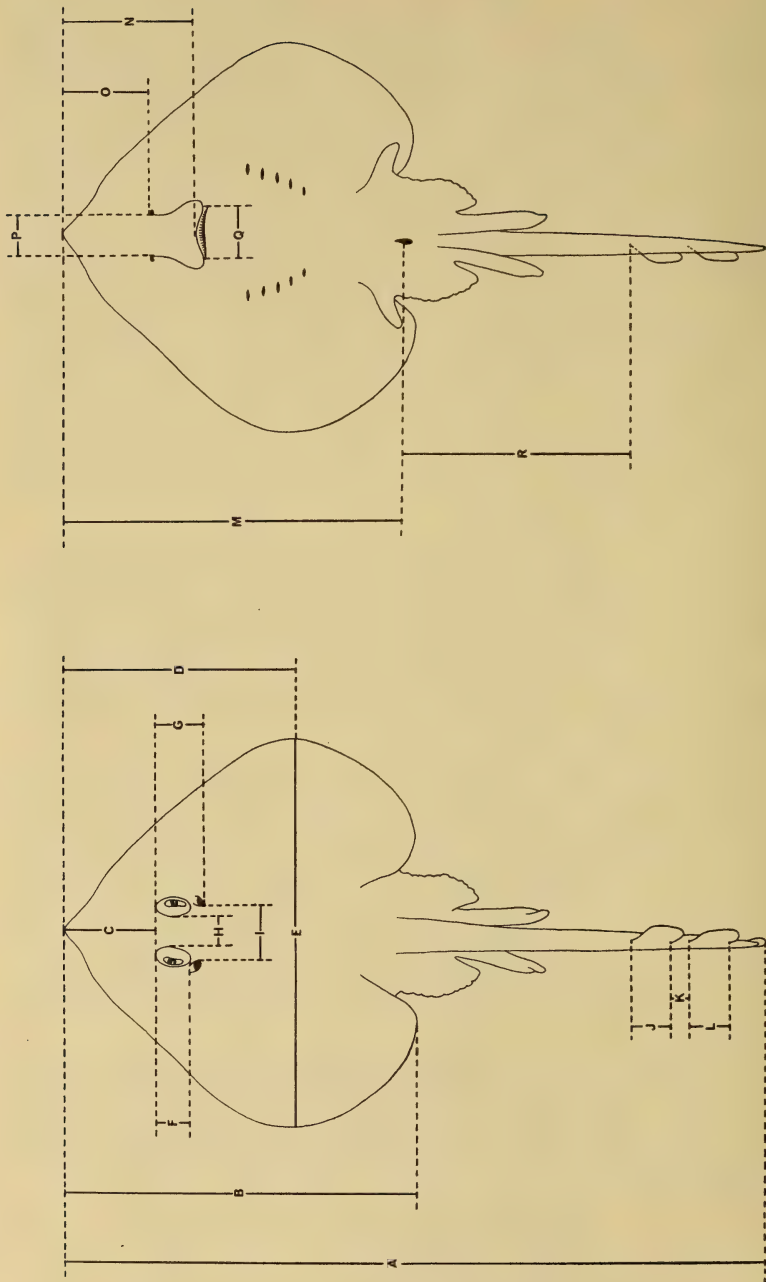


FIG. 1. Scheme of measurement for skate specimens.

A—total length; B—disc length; C—snout length; D—snout to greatest disc width; E—disc width; F—longitudinal diameter of eye; G—eye and spiracle; H—interorbital distance; I—interspiracular distance; J—base length of first dorsal fin; K—interdorsal space; L—base length of second dorsal fin; M—snout to middle of vent; N—preoral length; O—prenasal length; P—internasal distance; Q—mouth width; R—middle of vent to origin of first dorsal fin.

but not whip-like, with caudal fin reduced to a membranous fold. Two dorsal fins. Pelvic fins with outer margins either weakly concave, or so deeply concave that anterior lobe forms separate, three-jointed, limb-like structure. Skin on dorsal surface of disc and tail with small spinules and spines, or larger thorn-like denticles, or both, but without serrate tail spines. Ventral surface smooth, or with pointed spines, or with small, flattened asperities.

In this family eight genera are distinguished, but only three of these occur in the eastern South Atlantic.

Key to Genera

- 1 (a) Anterior lobe of pelvic fin forming slender, three-jointed limb-like structure, separate externally from posterior fin-like region (fig. 2 A) *Cruriraja*
- (b) Anterior lobe of pelvic fin continuous externally with posterior region along outer margin of fin, not forming a separate limb (fig. 2 B) 2
- 2 (a) Anterior radials of pectoral fins falling distinctly short of tip of snout; rostral appendices fused to stout, rod-like rostral bar throughout their length. Shield usually present in clasper glans (figs 5-11, 15, 17-19) *Raja*
- (b) Anterior radials of pectoral fins extending almost to tip of snout; rostral appendices broadly united basally and hanging posteriorly free from soft, delicate rostral bar, without anterior notch; each appendix separated posteriorly from axial bar by a notch about $\frac{1}{2}$ as long as appendix. Shield absent in clasper glans (fig. 21 B) *Bathyraja*



FIG. 2. Ventral surface of pelvic fin: A. *Cruriraja*; B. *Raja*.

Genus CRURIRAJA Bigelow & Schroeder

Cruriraja Bigelow & Schroeder, 1948: 549; 1953: 313. Smith, 1964: 286. Wallace, 1967: 7, fig. 3.

Type-species: *Cruriraja atlantis* Bigelow & Schroeder, 1948.

Pectorals with radials of ordinary form, without lateral processes. Outer margins of pelvics deeply notched, to form an anterior, limb-like structure, consisting of three articulated segments, externally distinct from posterior, fin-like lobe of pelvic. Tips of anterior rays of pectorals falling short of tip of rostral cartilage.

Three species of *Cruriraja* have been recorded in the southern African region (Smith, 1964); one east coast species, one west coast species and one species common to both coasts.

Key to species

- 1 (a) No thorns on tip of snout, along rostral ridge or in interspace between dorsal fins *C. durbanensis*
- (b) A group of spines on tip of snout and along rostral ridge; thorns in dorsal interspace 2
- 2 (a) No thorns on mid-line of back above anterior half of abdominal region. Interdorsal space usually less than half base length of first dorsal. Single enlarged thorn on anterior dorsal border of clasper glans; ventral border with dermal denticles. . . *C. triangularis*
- (b) Thorns present on mid-line of back above anterior half of abdominal region. Interdorsal space usually greater than half base length of first dorsal. A single, enlarged thorn on anterior dorsal border of clasper glans and an eperon on anterior ventral border (fig. 4) *C. parcomaculata*

Cruriraja durbanensis (Von Bonde & Swart, 1923)

(Fig. 3)

Raja durbanensis Von Bonde & Swart, 1923: 11, pl. 22, fig. 1. Barnard, 1925: 69.

Cruriraja durbanensis: Bigelow & Schroeder, 1948: 550; 1953: 315; 1962: 199. Smith, 1964: 287. Wallace, 1967: 7.

Types

The holotype, a juvenile male (232 mm total length) taken in 859 metres at 30°10'00'S, 14°33'00'E, formerly in the collection of the Government Marine Survey; now missing. The paratype, a female (311 mm total length) also missing. The locality and depth for the paratype are noted as unknown.

Material

No specimens were available.

Unfortunately, the name *C. durbanensis* is misleading, as the type locality given for this species, Station 343 (Von Bonde & Swart, 1923), is at a point in the Atlantic Ocean about 640 km north-west of Cape Town. Bigelow & Schroeder (1948, 1953) erroneously give the locality as off the Natal coast in 420 fathoms (769 m).

C. durbanensis is most easily distinguished from all other species of this genus by the fact that there are no thorns on the snout and rostral cartilage, and no thorns in the interdorsal space.

Description (Barnard, 1925: 69)

'Width equal to distance from snout almost to middle of tail. In male snout pointed but not produced, about 90°, anterior margin almost straight. In female snout rounded, without point, anterior margins undulate. Outer pectoral angle broadly rounded, hind margin moderately convex. Eye a little less than interorbital width, 4 in preocular length of snout. Whole upper surface of disc and upper and lateral surfaces of tail covered with spinelets; in male 1 large spine in front of, 2 behind orbit; in female 5 and three respectively; 2 (male) or 1 (female) suprascapular spines; a median row from occiput

to 1st dorsal in male; in female only extending about half-way along tail; lower surface quite smooth.'

Colour

'Reddish brown, lighter beneath.'

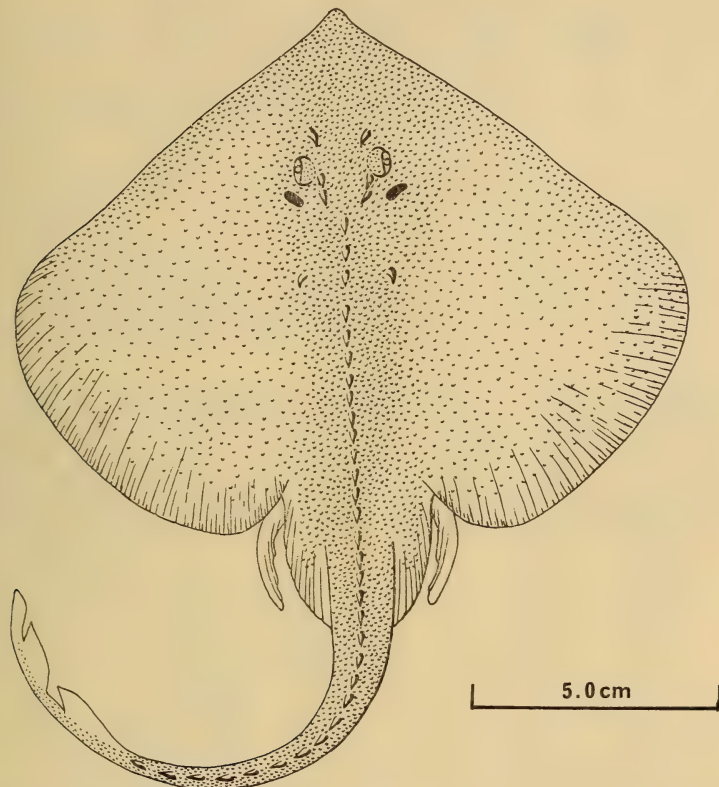


FIG. 3. *Cruriraja durbanensis*: the type, immature male. Dorsal view. (After Von Bonde & Swart, 1923.)

Cruriraja parcomaculata (Von Bonde & Swart, 1923)

(Pl. 1A; Figs 4 A, 4 B)

Raja parcomaculata Von Bonde & Swart, 1923: 9, pl. 21, fig. 2.

Raja parcomaculata: Norman, 1935: 46.

Raja miraletus (non Linnaeus) Barnard, 1925: 68 (*partim*).

Raja smithi (non Müller & Henle) Smith, 1961: 66, fig. 68.

Raja caudaspinosa (non Von Bonde & Swart) Norman, 1935: 43 (*partim*).

Cruriraja parcomaculata: Bigelow & Schroeder, 1948: 550; 1953: 315; 1962: 199. Smith, 1964: 288, pl. 26, fig. 27. Wallace, 1967: 11.

Types

The holotype, a juvenile (181 mm total length), trawled off Durban (29°57'30'S, 31°34'15'E) in 545 metres, formerly in the collection of the

Government Marine Survey; now missing. A single paratype, juvenile female (108 mm total length) taken at the same locality and formerly in the same collection, now in the collection of the British Museum (Natural History).

Material

11 specimens of both sexes (160–550 mm total length) trawled off the west coast from WNW Lüderitzbucht to Cape Columbine in 267–622 metres and from the east coast in Algoa Bay at 193 metres. 8 specimens preserved in the collection of the South African Museum (SAM 24352–4, 24412, 24662).

C. parcomaculata was thought to be an east coast species (Smith, 1964), but it is now known to occur along the south and west coasts of southern Africa, where it is taken fairly regularly in commercial trawls. While the type specimens were taken off Durban (Von Bonde & Swart, 1923), Wallace (1967) has not recorded the species during a three-year survey, so that *C. parcomaculata* probably does not extend further north than about Port Alfred on the east coast, and is replaced by *C. triangularis* in the region Durban to Barra da Falsa (Wallace, 1967).

C. parcomaculata closely resembles the east coast species *C. triangularis*, but differs from it in having a comparatively broader disc, a greater interdorsal space and a continuous median series of thorns along the back, which in adults, where there is development of lateral rows, gives rise to the distinctive 'cross' pattern of spines. It should be noted that the definitive character given

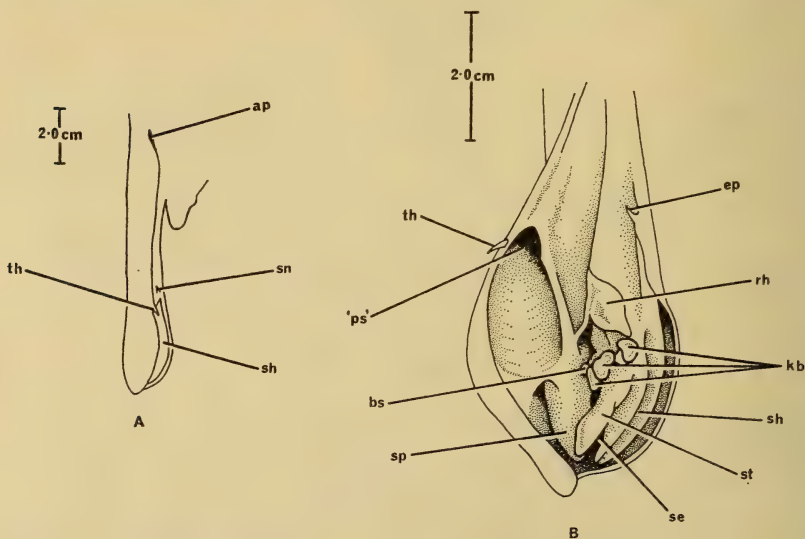


FIG. 4. *Cruriraja parcomaculata*.

A: external view of right clasper from the dorsal side.

B: lateral view of right clasper, opened to show structural features of the glans.

ap—apopyle; bs—boss; hp—hypopyle; kn—knob; 'ps'—'pseudosiphon'; rh—rhypidion; sh—shield; ep—eperon; sp—spike; st—sentinel; th—thorn; se—sentina.

by Smith (1964) for the separation of the two species—the position of the line across the widest part of the disc—is not so marked in adults, where there is an overlap of critical values. Comparison of the claspers of the two species has shown that there are major differences in both external and internal structures. This confirms that *C. parcomaculata* and *C. triangularis* are distinct species.

A large specimen (BM. 1935. 5.2.64) taken by the *Discovery* and identified as *R. caudaspinosa* by Norman (1935) is in fact *C. parcomaculata*.

TABLE 2. *C. parcomaculata*. Measurements expressed as permillage of the total length. Number of specimens 11.

Character	Mean	Range
Total length	1 000	
Disc width	591	568–627
Disc length	451	427–521
Snout to greatest disc width	273	249–314
Snout to middle of vent	390	360–437
Middle of vent to 1st dorsal origin	479	459–519
Snout length	95	84–108
Preoral length	110	99–118
Prenasal length	83	76–88
Eye, longitudinal diameter	41	29–55
Eye and spiracle	52	44–60
Spiracle	23	16–31
Interorbital distance	32	28–38
Interspiracular distance	71	66–82
Internasal distance	50	44–59
Mouth width	61	52–70
Gill slit lengths: 1st	16	14–21
3rd	17	15–20
5th	14	10–17
Distance between inner ends of gill slits:		
1st	126	116–140
5th	53	46–60
Pelvic fin (anterior lobe):		
anterior margin	114	101–133
length	97	79–116
base width	27	21–34
1st dorsal fin: height	28	20–34
base length	42	32–59
2nd dorsal fin: height	27	20–35
base length	38	32–48
Interdorsal space	39	28–49

Description

Disc 1.2–1.4 times as broad as long, its width 1.6–1.8 in total length; angular in front, with maximum angle in front of spiracles 120° in juveniles and females and 112° in adult males; anterior margins weakly concave close behind tip of snout and again at level of spiracles; outer angles narrowly rounded, posterior angles broadly so; posterior and inner margins convex. Axis of greatest breadth 1.4–1.6 times as far from tip of snout as from posterior edge of disc. Tail with lateral folds, well developed and expanded on posterior third, so that tail is narrower at middle of length than distally; its length from

middle of vent to origin of first dorsal fin 1.1–1.2 times the distance from middle of vent to tip of snout; its length from middle of vent to tip of tail 1.4–1.7 times the distance from middle of vent to tip of snout.

Juvenile specimens with 5 thorns around inner edge of each orbit and 1 pair of widely separated thorns between spiracles; 1 median nuchal thorn and 2 scapular thorns on each side; a row of 23–27 thorns along mid-line of back and tail, extending from immediately behind scapular region to origin of first dorsal; median row flanked on each side by an irregular series of smaller spines; 2–3 thorns in dorsal interspace. Whole upper surface of disc with fine spinules, except on outer posterior edges; larger spines on tip of snout and along anterior margins. Lower surface of disc and tail completely smooth.

Adult specimens with 11–13 thorns around inner margin of each orbit and spiracle; 2 pairs of thorns between spiracles; 2 (sometimes 4) median nuchal thorns, usually arranged in a double series; 3 scapular thorns on each side; 4–5 irregular rows of stellate-based thorns along mid-dorsal region from nuchal thorns to origin of first dorsal, diminishing to a double series of slender, recurved thorns about half-way along tail; a single lateral row of smaller spines on each side of tail, from about posterior edge of pelvics to about level of dorsal interspace; 4–8 thorns in interspace between dorsals. A group of thorns on tip of snout and along rostral cartilage, and numerous, irregularly arranged, stellate-based spines along anterior margins of disc to outer angles. Otherwise smooth on upper surface, except in some cases a few small spines at inner margin of pectoral. Lower surface of disc and tail without spines.

Snout slightly pointed but not produced, its length in front of orbits 2.6–3.5 times as long as distance between orbits; its length in front of mouth 1.9–2.4 times as long as spiracles; distance between orbits 1.0–1.8 in length of orbit. Rostral cartilage projecting from cranium as hard bar; anterior rays of pectorals extending about half the distance from front of orbits to tip of snout.

Mouth almost straight; nasal curtain not fringed; expanded posterior margin of nostril conspicuously fringed. Teeth arranged in 39–44 rows in upper jaw, juveniles with 30–31 rows; teeth blunt and flat and arranged in quincunx in juveniles, but sharp pointed and regularly arranged in adults.

Pelvic fins divided into slender, limb-like anterior lobe, arising separately from ventral surface of disc, and posterior fin-like lobe.

Dorsal fins similar in shape with rounded apices; first dorsal usually larger than second; dorsal interspace varying considerably from 0.6–1.5 times as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 66–69.

Colour

Juveniles uniformly brown, sometimes with scattered darker patches on disc and tail. Adults typically uniformly brown, with irregular lighter and darker areas. Lower surface of disc and tail white.

Genus *RAJA* Linnaeus, 1758*Raja* Linnaeus, 1758: 231.Type-species: *Raja clavata* Linnaeus, 1758 (as designated by Jordan & Gilbert, 1883).

Pectorals with radials of ordinary form, without lateral processes. Outer margins of pelvics more or less concave, but not deeply notched and not forming separate, limb-like structure. Tips of anterior rays of pectoral fins falling short of rostral appendices. Rostral cartilage stout and bar-like, without segment; rostral appendices fused to lateral edges of rostral cartilage throughout length. Characters otherwise the same as for the family.

Genus *BATHYRAJA* Ishiyama, 1968*Bathyrāja* Ishiyama & Hubbs, 1968: 407, figs 1, 2.Type-species: *Bathyrāja isotrachys* (Günther, 1877)

Pectorals with radials of ordinary form, without lateral processes. Outer margins of pelvics more or less concave, but not forming a separate, anterior, limb-like structure. Rostral appendices broadly united basally with rostral bar, and extending posteriorly as unnotched processes; posterior wings of rostral appendices separate from rostral bar. Shield absent in clasper glans. Characters otherwise the same as for the family.

Note: Ishiyama & Hubbs (1968) also define the genus *Bathyrāja* by the presence of a pseudosiphon in the clasper glans. Investigation of the claspers of the *radiata*-complex has revealed that a true pseudosiphon, as defined by Ishiyama (1958) and subsequently modified by Ishiyama & Hubbs (1968), is definitely present in the species *R. radiata*, *R. doellojuradoi*, *R. hyperborea* and *R. robertsi* n.sp. Furthermore, Ishiyama & Hubbs (1968) restrict *Bathyrāja* to the Indo-Pacific and *Breviraja* to the Atlantic, but the distributional pattern of *Bathyrāja smithii* shows this to be incorrect. Krefft (personal communication) suggests that *Breviraja* is confined to slope areas in the tropics, whereas *Bathyrāja* is a bipolar, antitropical genus.

KEY TO SPECIES OF *Raja* AND *Bathyrāja*

- 1 (a) Mucus pores on ventral surface of disc pigmented, appearing as small black spots and streaks 2
- (b) Mucus pores on ventral surface of disc not pigmented 6
- 2 (a) Tail long and slender; snout markedly produced and very pointed *R. lanceorostrata*
- (b) Tail not long and slender; snout somewhat pointed but not very produced 3
- 3 (a) Ventral surface of disc completely covered by small, close-set asperities *R. springeri*
- (b) Ventral surface of disc never completely covered by small asperities, although spines and spinules may be present on tip of snout, internasal region and anterior margins of disc 4
- 4 (a) Distance from middle of vent to tip of snout greater than distance from middle of vent to tip of tail, by an amount about equal to or greater than the preoral length *R. doutrei*
- (b) Distance from middle of vent to tip of snout equal to or greater than the distance from middle of vent to tip of tail, by an amount less than half the preoral length 5
- 5 (a) Snout produced; interorbital distance about 5.5 in snout length; internasal distance about 3 in preoral length *R. stenorhynchus*

KEY TO SPECIES OF *Raja* AND *Bathyraja* (continued)

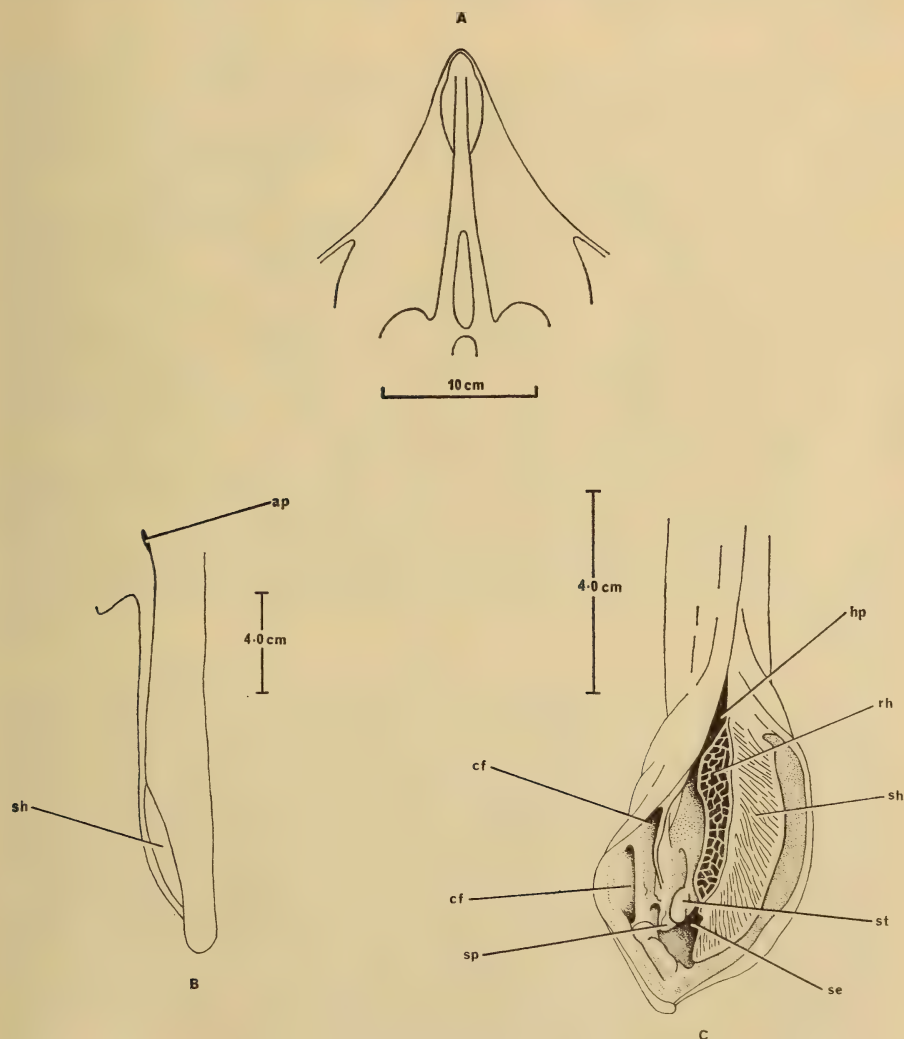
- (b) Snout not produced; interorbital distance 3-4 in snout length; internasal distance about 2 in preoral length *R. pullopunctata*
- 6 (a) Distance from middle of vent to origin of first dorsal fin greater than distance from middle of vent to tip of snout 7
- (b) Distance from middle of vent to origin of first dorsal fin less than distance from middle of vent to tip of snout 8
- 7 (a) Upper surface of disc and tail completely covered with fine spinules; a single row of spines along mid-dorsal region of back and tail *R. spinacidermis*
- (b) Upper surface of disc and tail without close-set spinules; 3 rows of thorns along mid-dorsal region of back and 5 rows on tail *R. caudaspinosa*
- 8 (a) Upper surface of disc and tail completely covered with fine, close-set spinules; no enlarged thorns on disc or tail *R. spinacidermis*
- (b) Upper surface of disc and tail never completely covered with spinules (except some juveniles); larger thorns always present on disc or tail 9
- 9 (a) Less than 30 rows of teeth in upper jaw *B. smithii*
- (b) More than 30 rows of teeth in upper jaw 10
- 10 (a) Snout produced and sharply pointed *R. alba*
- (b) Snout not produced and not sharply pointed 11
- 11 (a) Ocelli present on upper surface of disc 12
- (b) Ocelli absent on upper surface of disc 14
- 12 (a) Ocelli black and yellow marbled 21
- (b) Ocelli not marbled 13
- 13 (a) Ocelli circular or only very slightly ovate, usually consisting of three definite rings of colour *R. miraletus*
- (b) Ocelli strongly horizontally ovate, consisting of a single dark ring enclosing one or two dark spots *R. clavata*
- 14 (a) Distance from middle of vent to tip of snout about 1.5 times greater than distance from middle of vent to tip of tail 15
- (b) Distance from middle of vent to tip of snout less than distance from middle of vent to tip of tail 16
- 15 (a) Upper surface of disc with stellate-based thorns on anterior margins, rostral cartilage and posterior angles. Ventral surface of disc white with some scattered darker blotches *R. radiata*
- (b) Upper surface of disc without stellate based thorns on anterior margins, rostral cartilage and posterior angles. Ventral surface of disc dark grey with white triangular patches between nostrils, around mouth and at pectoral girdle *R. robertsi*
- 16 (a) Less than 50 rows of teeth in upper jaw 17
- (b) More than 50 rows of teeth in upper jaw 21
- 17 (a) Median row of thorns along back and tail absent. No thorns on rostral cartilage *R. ravidula*
- (b) Median row of thorns on back and tail always present. Thorns present on rostral cartilage 18
- 18 (a) A single row of thorns along mid-dorsal region of back and tail; auxiliary rows of thorns (when present) always lateral. Number of precaudal vertebrae 46-54 19
- (b) 3 or more rows of thorns along mid-dorsal region of back and tail; auxiliary rows of thorns semi-lateral in position; number of precaudal vertebrae 55-69 20
- 19 (a) Shield in clasper glans well developed and exposed (fig. 11 C); dorsal surface of disc grey with numerous darker regular spots. *R. straeleni*
- (b) Shield in clasper glans poorly developed (fig. 10 C); dorsal surface of disc with or without numerous irregular darker blotches. *R. clavata*
- 20 (a) Reduction in size to eventual loss of mid-dorsal rows of thorns from disc to tail; lower surface of tail uniformly grey with white distal tip; precaudal vertebral count 65-69; clasper with a slit and a cleft (fig. 15 C) *R. dissimilis*
- (b) Mid-dorsal rows of thorns large and continuous to origin of first dorsal fin; lower surface of tail white or with scattered darker blotches; precaudal vertebral count 55-63; clasper with two slits (fig. 17 C) *R. confundens*

KEY TO SPECIES OF *Raja* AND *Bathyraja* (continued)

- 21 (a) Distance from middle of vent to origin of first dorsal fin longer than distance from tip of snout to greatest disc width, by an amount greater than the preoral length; precaudal vertebral count 70; spike in clasper glans bilobed (fig. 19 C) *R. wallacei*
- (b) Distance from middle of vent to origin of first dorsal fin longer than distance from tip of snout to greatest disc width, by an amount less than the preoral length; precaudal vertebral count 55-58; spike in clasper glans bulbous but not bilobed (fig. 18 C)

R. leopardus

Note: *R. ackleyi* Garman has been recorded from the south Atlantic (Poll, 1951) at 3°10'S, 9°36'E and 4°58'S, 11°20'30"E, but this is outside the area of this survey.

FIG. 5. *Raja doutrei*.

A: rostral bar and rostral appendices.

B: external view of left clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apophysis; cf—cleft; hp—hypopyle; rh—rhipidion; sh—shield; sp—spike; st—sentinel.

Raja doutrei Cadenat, 1960

(Pl. 1B; Figs 5 A, B, C)

Raja doutrei Cadenat, 1960: 294, figs 1-11, 13, 15.*Raja batis* (non Linnaeus) Hulley, 1966: 512.*Type*

The holotype, a juvenile male (591 mm total length) taken at Sud Fosse Kayar, Senegal, in 450-500 metres in the collection of the Muséum National d'Histoire Naturelle, Paris.

Material

Two adult males (845, 931 mm total length) taken SW by W Lüderitzbucht in 494 metres. Both specimens in the collection of the South African Museum (SAM 24699, 24700). A single female (SAM 34564) from the same locality not suitable for measurement.

This is a new record for this species in the South Atlantic. The specimens were originally thought to be *R. batis* Linnaeus (Hulley, 1966), but comparison of the claspers with those of *R. batis* from the North Atlantic (Hulley, 1966: figs 6, 7) has revealed that these specimens do not belong to the latter species. However, the specimens are identical in shape, coloration, teeth count and spination pattern, particularly on the tail, to *R. doutrei* from the coast of Senegal (Cadenat, 1960). Counts of the number of precaudal vertebrae (Vpr_{cd} 46 in the type) confirm this identification.

R. doutrei closely resembles the east coast species *R. stenorhynchus*, but may be distinguished from this species by its comparatively shorter, narrower snout, longer and wider disc, and by its longer tail. Furthermore, it appears that the tooth count in the upper jaw is slightly lower than that of *R. stenorhynchus*, although the validity of this small difference as a taxonomic character is open to question.

Description

Disc about 1.2 times as broad as long, its width 1.3-1.4 in total length; maximum angle in front of spiracles 72°; anterior margins sinuous from snout to outer angles, convex at level of nostrils and concave a little behind level of mouth; outer angles sharply rounded, posterior margins gently convex. Axis of greatest breadth 1.5-1.9 times as far from tip of snout as from posterior edge of disc. Tail expanded distally with well-developed lateral folds, especially on posterior third; its length from middle of vent to origin of first dorsal fin 2.0-2.2 in length from middle of vent to tip of snout; its complete length from middle of vent to tip of tail 1.5 in length from middle of vent to tip of snout.

Adults with 6-7 thorns around inner margins of each orbit and above each spiracle; 0-1 very small, median nuchal thorn. A series of 13-26 thorns along midline of tail from above vent to origin of first dorsal; 1-2 thorns in dorsal interspace. No lateral rows of thorns on tail in adult males, but females typically with thorns in a single series on each side. Spines on dorsal surface

TABLE 3. *R. doutrei*. Measurements expressed as permillage of the total length.
Number of specimens 2.

Character	SAM	
	24699	24700
Total length	1 000	1 000
Disc width	723	751
Disc length	605	626
Snout to greatest disc width	398	374
Snout to middle of vent	595	600
Middle of vent to 1st dorsal origin	300	269
Snout length	197	199
Preoral length	192	192
Prenasal length	175	173
Eye: longitudinal diameter	38	46
Eye and spiracle	53	56
Spiracle	17	23
Interorbital distance	51	50
Interspiracular distance	71	68
Internasal distance	91	95
Mouth width	91	99
Gill slit lengths 1st	17	19
3rd	17	20
5th	13	17
Distance between inner ends of gill slits:		
1st	153	164
5th	94	95
1st dorsal fin: height	33	44
base length	49	45
2nd dorsal fin: height	49	45
base length	48	45
Interdorsal space	18	17

on tip of snout and along anterior margins of disc from about opposite eyes to outer angles. Ventral surface with spines on snout and along anterior margins to level of mouth. Otherwise smooth on both dorsal and ventral surfaces.

Snout produced and slightly pointed, its length in front of orbits 3·8–4·0 times as long as distance between orbits; its length in front of mouth 2·0–2·1 times as great as distance between nostrils. Orbits 2·0–2·2 times as long as spiracles; distance between orbits 1·1–1·3 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior tips of pectoral fins falling short of appendices.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 32 regular rows in upper jaw, each with a single, large, posterior cusp.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in size and shape, with broadly rounded apices. Small but definite interspace between dorsals, its length 37% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 47-49 (male), 43 (female).

Colour

Upper surface of disc and tail uniformly brown, with some scattered, irregular, darker blotches. Lower surface brown; terminal ends of mucus pores pigmented, appearing as widely-spaced black spots on the snout and anterior margins of the disc.

Raja pullopunctata Smith, 1964

(Pl. 2 A, B, Figs 6 A, B, C)

Raja pullopunctata Smith, 1964: 285, pl. 25.

Raja pullopunctata: Hulley, 1966: 505, figs 4, 5. Wallace, 1967: 13, fig. 7.

Raja batis (non Linnaeus) Thompson, 1914: 156. Von Bonde & Swart, 1923: 3. Barnard, 1925: 70, non pl. 4, fig. 3. Smith, 1961: 66, pl. 3, fig. 65.

Raja batis (non Linnaeus) Norman, 1935: 39. Fowler, 1941: 385. Bigelow & Schroeder, 1953: 146.

Raja campbelli Wallace, 1967: 24, fig. 12.

Raja stabuliformis: Von Bonde & Swart, 1923: 12.

Types

The holotype of *R. pullopunctata*, a juvenile male (205 mm total length) and paratype, a female (175 mm total length), both trawled in 183 metres in Algoa Bay, in the collection of the J. L. B. Smith Institute of Ichthyology, Grahamstown.

The holotype of *R. campbelli*, a female (663 mm total length) and paratype, a male (386 mm total length), trawled east of Durban in 320 metres and north-east of Durban in 137 metres respectively, in the collection of the Oceanographic Research Institute, Durban.

Material

Seven female and four male specimens (221-1250 mm total length) trawled from west of Cape Town to Port Alfred in 91-457 metres, including the types and paratypes of *R. pullopunctata* and *R. campbelli*. Eight specimens preserved in the collection of the South African Museum (SAM 22635, 22652, 24349-51, 24456, 24497).

On the basis of external morphology, Smith (1964) distinguished between *R. pullopunctata* and the European species *R. batis*, to which the South African material had previously been referred. This distinction has been confirmed by Hulley (1966) after detailed examination of the clasper structures of the two species.

Recently Wallace (1967) has described a new species of 'black-bellied' skate, *R. campbelli*, from the Natal coast. This species closely resembles *R. pullopunctata* but was distinguished from it on the basis of the shape of the snout and the spination of the rostral cartilage. It must be pointed out, however, that Wallace only examined juvenile specimens of *R. pullopunctata* (340 mm maximum total length). Specimens of *R. pullopunctata* in the collection of the South African Museum, show a range of variation in the above characters.

In more mature specimens (387–1250 mm total length) spinules appear first on the ventral tip and then on the dorsal tip of the rostral cartilage, while the shape of the snout varies with age: width of disc at level of orbits 2.3–2.6 times the preorbital length of the snout in juveniles (221–344 mm total length); 2.0–2.3 times in more mature specimens (387–540 mm total length); and

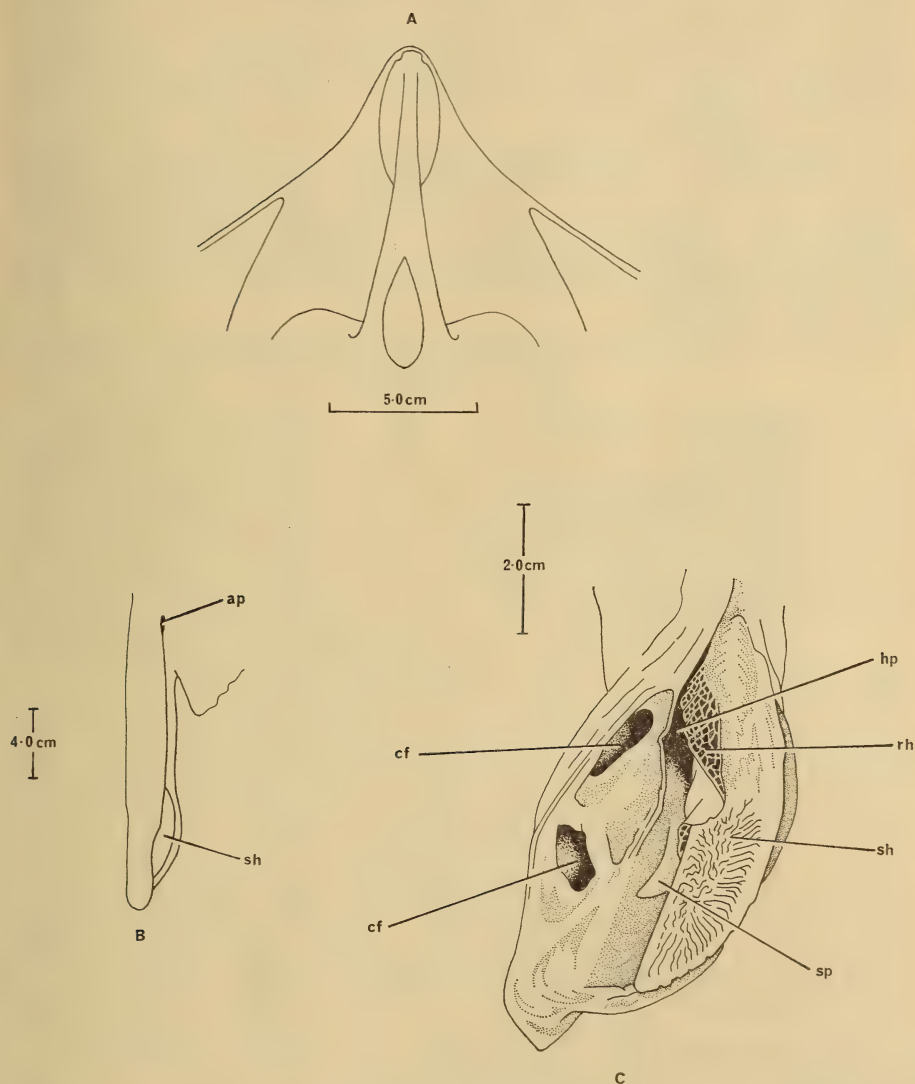


FIG. 6. *Raja pullopunctata*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apophysis; cf—cleft; hp—hypophysis; rh—rhipidion; sh—shield; sp—spike.

1.8–1.9 times in adult specimens (660–1250 mm total length). It is therefore held that specimens described as *R. campbelli* are specimens of *R. pullopunctata*. This is further supported by the fact that there is no difference in the precaudal vertebral count between the two species.

R. pullopunctata most closely resembles *R. flavirostris* Philippi from the Falkland Islands, but may be distinguished from this species by the length of the tail and by the number of teeth in the upper jaw. Examination of the claspers of *R. flavirostris* has shown the two species to be distinct. Furthermore, the precaudal vertebral count in *R. flavirostris* appears to be slightly less than that for *R. pullopunctata*.

R. pullopunctata is most easily distinguished from other South African skates, except *R. lanceorostrata* and *R. stenorhynchus*, by the black-spotted ventral surface of the disc and by the presence of a single large, median nuchal thorn (sometimes 2). It may be separated from *R. lanceorostrata* by the shape of the tail and snout, and from *R. stenorhynchus* by the shape of the disc and the nature of the rostral cartilage.

TABLE 4. *R. pullopunctata*. Measurements expressed as permillage of the total length. Number of specimens 10.

Character	Mean	Range
Total length	1 000	
Disc width	734	678–784
Disc length	573	550–598
Snout to greatest disc width	320	294–366
Snout to middle of vent	526	493–567
Middle of vent to 1st dorsal origin	304	272–323
Snout length	165	147–189
Preoral length	167	156–183
Prenasal length	136	120–152
Eye: longitudinal diameter	40	29–46
Eye and spiracle	54	50–58
Spiracle	22	19–26
Interorbital distance	48	43–46
Interspiracular distance	72	70–75
Internasal distance	88	79–95
Mouth width	92	88–96
Gill slit lengths: 1st	15	12–20
2nd	16	12–23
5th	13	11–19
Distance between inner ends of gill slits:		
1st	162	155–171
5th	93	82–98
1st dorsal fin: height	34	24–39
base length	52	42–62
2nd dorsal fin: height	30	18–35
base length	49	40–58
Interdorsal space	28	21–36

Description

Disc about 1.2–1.4 times as broad as long, obtuse in front, with anterior angle in front of spiracles 92°–108°; anterior margins weakly concave posterior to snout in juveniles (width of disc at level of orbits 2.3–2.6 times in preorbital

length of snout), but more sinuous and particularly concave abreast of spiracles in older specimens (width of disc at level of orbits 1.8–2.3 times in preorbital length of snout); posterior and outer angles broadly rounded. Axis of greatest breadth 1.1–1.4 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds (wide in adults), its length from middle of vent to origin of first dorsal fin 1.6–1.9 in length of middle vent to tip of snout.

Juvenile specimens with 2 thorns in front of orbit and 1 behind; a single, large, median nuchal thorn; a row of 8–12 thorns along mid-line of tail, from above vent to origin of first dorsal fin; and 1 thorn in interspace between first and second dorsals. No lateral rows of spines on tail. Otherwise entire dorsal and ventral surfaces of disc and tail naked.

Larger specimens with 3–4 thorns around inner margin of orbit; a single, median nuchal thorn (sometimes worn); a row of 10–12 thorns along mid-line of tail, from above vent to origin of first dorsal; and 1–2 thorns in dorsal interspace. No lateral rows of thorns on tail. Upper surface of disc smooth, but lower surface with spinules on tip of snout and anterior edges of disc to about level of nostrils, and on internasal area.

Adult specimens with 5–8 thorns around inner margin of orbit; 1 median nuchal thorn (sometimes 2), usually worn; a row of 26–27 thorns along mid-line of tail, from above vent to origin of first dorsal; and 3–4 thorns in dorsal interspace. A single, irregular row of lateral caudal thorns (15–20) on each side of tail, from about posterior edge of pelvics to interspace between dorsals. Dorsal surface of disc and tail with widely spaced, blunt asperities, except on suprascapular region. Spinules on ventral surface of snout, anterior margins to level of nostrils and on internasal area.

Snout produced, more markedly so in adults, its length in front of orbits 3.4–4.1 times as long as distance between orbits; its length in front of mouth 1.9–2.0 times as great as distance between nostrils. Orbits 1.5–1.9 times as long as spiracles; distance between orbits 1.5–1.9 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to the bar throughout their length; tips of anterior rays of pectoral fins falling short of appendices.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril heavily fringed. Teeth with single, large cusp in males, but more or less flat in females and juveniles, arranged in 53–58 rows in upper jaw.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First dorsal fin usually only slightly larger than second, but similar in shape, with convex anterior margin and broadly rounded apex; interspace between dorsals 47–73% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 50–58.

Colour

Dorsal surface light brown to biscuit, sometimes darker, with numerous

small darker spots and blotches. Ventral surface greyish, with terminal ends of mucus pores darkly pigmented, appearing as black spots and streaks.

Raja caudaspinosa (Von Bonde & Swart, 1923)

(Pl. 3 A, B; Figs 7 A, B, C)

Raja caudaspinosa Von Bonde & Swart, 1923: 8, pl. 21, fig. 1. Barnard, 1925: 66.

Raja caudaspinosa: Norman, 1935: 43 (*partim*). Fowler, 1941: 376.

non Raja caudaspinosa: Smith, 1961: 67, *non* fig. 72 (= *R. leopardus*).

Raja albalinea Von Bonde & Swart, 1923: 6, pl. 20, fig. 1.

Types

The holotype of *R. caudaspinosa*, a female (346 mm total length), trawled off the Natal coast in 512 metres, formerly in the collection of the Government Marine Survey; now missing.

The paratype of *R. albalinea*, a juvenile female (108 mm total length), taken at 32°3'00"S, 16°2'00"E in 512 metres, formerly in the collection of the Government Marine Survey; now in the British Museum (Natural History). The type of *R. albalinea* taken by the Government Marine Survey, now missing.

Material

31 specimens of both sexes (304–580 mm total length) trawled between 292 and 914 metres from Port Nolloth to west of Cape Town. 29 specimens preserved in the collection of the South African Museum (SAM 23187, 24420, 24449).

Although the number of precaudal vertebrae in the tail is indicative of the genus *Bathyraja* (Ishiyama & Hubbs, 1968), this species has been retained in the genus *Raja* because of the structure of the rostral bar and rostral appendices, and because both a rhipidion and shield are present in the clasper glans.

While resembling *R. wallacei* and *R. confundens* in the heavy spination of the tail, *R. caudaspinosa* may be separated from these and from all other known South African species except juvenile specimens of *R. spinacidermis* by virtue of the fact that the distance from the middle of the vent to the origin of the first dorsal fin is greater than the distance from the middle of the vent to the tip of the snout. In this and other characters, *R. caudaspinosa* most closely resembles *R. fyllae* Lütken from the northern Atlantic, but differs in being comparatively narrower across the disc, having a shorter snout and a narrower tail than the latter species. Unlike *R. fyllae*, juvenile specimens of *R. caudaspinosa* possess dark cross-barring on the tail, which is more typical of *R. senta* Garman, but they differ from this species in spination. Furthermore, Bigelow & Schroeder (1953: 199) report that 'the range of *R. fyllae* appears to be defined by its preference for a narrow temperature range of a few degrees above the freezing point of salt water', so that while this condition may be satisfied on the South African west coast, it seems unlikely that it applies to the waters off Natal (type taken in 512 metres).

Examination of the type of *R. albalinea* led both Barnard (1925) and Norman (1935) to include this species as a synonym of *R. caudaspinosa*. Unfortunately the type is now missing, but a comparison of the position of the vent in the paratype with its position in *R. caudaspinosa* has led the present author to accept this synonymy.

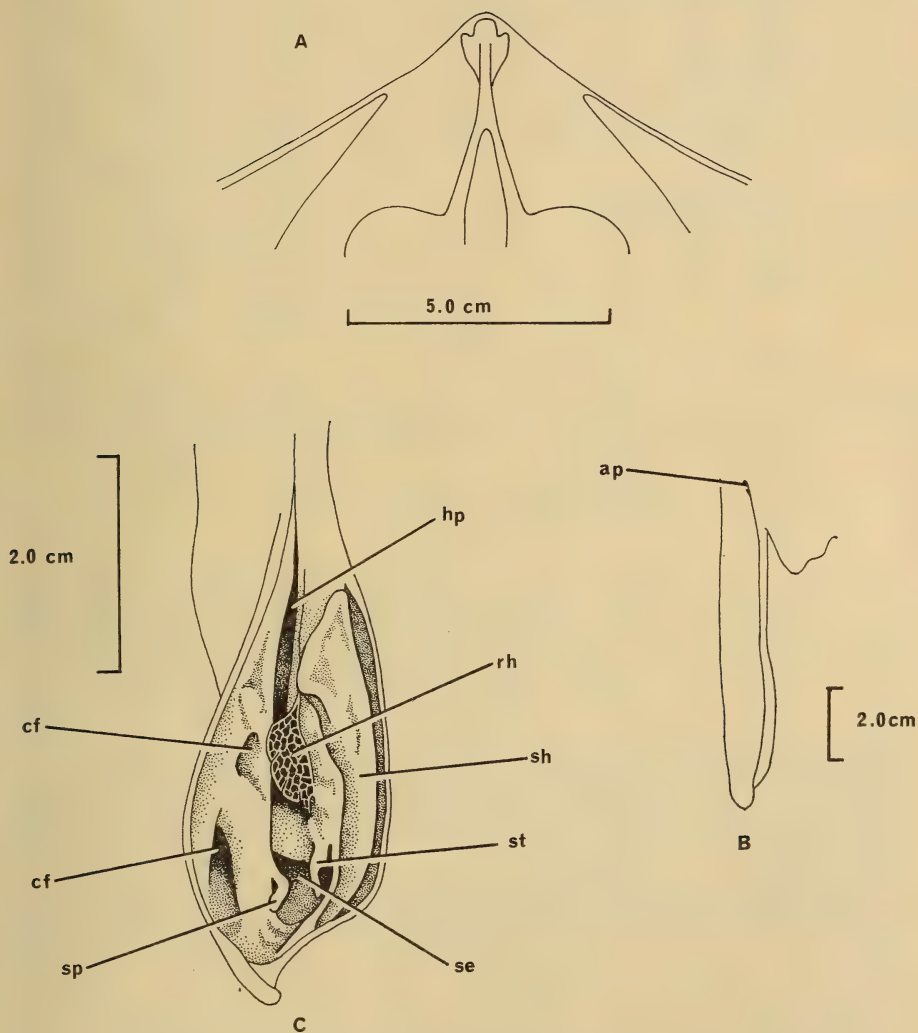


FIG. 7. *Raja caudaspinosa*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apopyle; cf—cleft; hp—hypopyle; rh—rhipidion; se—sentina; sh—shield; sp—spike; st—sentinel.

TABLE 5. *R. caudaspinosa*. Measurements expressed as permillage of the total length. Number of specimens 31.

Character	Mean	Range
Total length	1 000	
Disc width	547	520-573
Disc length	405	379-446
Snout to greatest disc width	250	214-273
Snout to middle of vent	393	372-409
Middle of vent to 1st dorsal origin	468	450-494
Snout length	78	66-87
Preoral length	85	72-96
Prenasal length	63	55-74
Eye: longitudinal diameter	40	36-43
Eye and spiracle	49	46-52
Spiracle	19	16-23
Interorbital distance	33	30-36
Interspiracular distance	66	59-74
Internasal distance	60	55-64
Mouth width	68	57-78
Gill slit lengths: 1st	15	11-18
3rd	17	13-18
5th	13	10-16
Distance between inner ends of gill slits:		
1st	137	126-144
5th	71	58-83
1st dorsal fin: height	26	20-36
base length	51	44-57
2nd dorsal fin: height	26	21-34
base length	51	43-59
Interdorsal space	0	

Description

Disc about 1.2-1.4 times as broad as long, its width 1.7-1.9 in total length; conspicuously obtuse in front, with maximum angle in front of spiracles 125° - 130° ; anterior margins evenly convex in juveniles, but considerably concave at level of spiracles in adults, and particularly indented in adult males; outer angles broadly rounded, posterior margins evenly convex. Axis of greatest breadth 1.1-1.9 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds along posterior third, its length from middle of vent to origin of first dorsal fin 1.1-1.3 times as great as distance from middle of vent to tip of snout.

Specimens typically with dorsal surface of disc smooth; large stellate-based thorns on anterior margins arranged in 4-6 irregular rows and on snout and rostral cartilage; 5-9 large thorns around inner margins of each orbit; 0-1 pair thorns between orbits and 1-2 pairs between spiracles; 4-5 median nuchal thorns with 3-5 thorns in a group posteriorly and 3-4 scapular thorns; a median series of 22-33 thorns along mid-line of back and tail to first dorsal origin, decreasing in size posteriorly, but never absent. Median series flanked by 1 row of equally large thorns on back, and 2 rows on each side on tail, making 5 rows of thorns in this region; lateral rows extending to origin of second dorsal. No interdorsal thorns. Small spines and spinules on anterior

edges of disc and on tail. Dorsal fins spinulose. Ventral surface smooth.

Snout obtuse and not produced, its length in front of orbits 2.0–2.6 times as long as distance between orbits; its length in front of mouth 1.2–1.6 times as great as distance between nostrils. Orbits 1.4–2.7 times as long as spiracles; distance between orbits 1.1–1.4 in length of orbit. Rostral cartilage projecting from cranium as hard bar with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending about two-thirds the distance forward from level of front of orbits towards tip of snout.

Mouth arched medially; nasal curtain deeply fringed; expanded posterior margin of nostril heavily fringed. Teeth in 32–36 rows in upper jaw, arranged in quincunx and closely crowded medially; flattened and blunt in females but with sharp posterior cusp in males.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First and second dorsals confluent; second dorsal a little longer and lower than first, and continuous with caudal.

Number of precaudal vertebrae (Vprd) 66–73.

Colour

Upper surface of disc dusky-grey to brown, with or without some darker spots. Lower surface of disc and tail pale.

Raja spinacidermis Barnard, 1923

(Pl. 4 A, B)

Raja spinacidermis Barnard, 1923: 440; 1925: 73, pl. 4, fig. 6. Smith, 1961: 66.

Raja spinacidermis: Norman, 1935: 46. Fowler, 1941: 392.

Raja mollis Bigelow & Schroeder, 1950: 388, pl. 2; 1953: 237, fig. 51. Templeman, 1965: 268, figs 10–13. Krefft & Lübben, 1966: 389, figs 1, 2.

? *Raja plutonia*: Barnard, 1925: 68.

Type

The holotype of *R. spinacidermis*, a female (600 mm total length), probably trawled off Cape Point in deep water (locality label lost), formerly in the collection of the South African Museum; now in the collection of the British Museum (Natural History).

The holotype of *R. mollis*, a juvenile male (262 mm total length), from 41°53'N, 65°35'W in 1568 metres, in the collection of the United States National Museum.

Material

The holotype and two specimens, a juvenile male (377 mm total length) and a juvenile female (638.5 mm total length), taken by R.V. *Walther Herwig* at Station WH 195/67 (33°49'S, 17°13'E) in 1 000 metres, and at Station WH 196/67 (33°51'S, 17°41'E) in about 1 350 metres. These two specimens in the collection of the Institut für Seefischerei, Hamburg.

This species is retained in the genus *Raja* because the rostral bar extends

forwards beyond the anterior extremities of the pectoral rays, and because the precaudal vertebral count is within the range for this genus (Ishiyama, 1967).

R. spinacidermis was previously known only from a single adolescent specimen, the holotype, but two specimens were taken by R.V. Walther Herwig in deep water off Cape Town in 1967. It may be distinguished from all other known South African species by the spinulose nature of the whole upper surface of the disc and tail and by the complete absence of larger thorns.

R. mollis, which has been taken in deep water in the eastern and western North Atlantic (Bigelow & Schroeder, 1950, 1953; Templeman, 1965; Krefft & Lübben, 1966), so closely resembles *R. spinacidermis* in proportional dimensions, tooth count and in its peculiar spination pattern, that it is considered that these two species are synonymous. However, the vertebral count in *R. mollis* (Vtr 25-29; Vprd 67-72) is slightly higher than that of *R. spinacidermis* (Vtr 25; Vprd 60-65), the difference probably being due to environmental factors. Although the two are widely separated geographically, this fact seems to have little systematic bearing so far as deep-water species are concerned, cf. *R. richardsoni* (Garrick, 1961; Forster, 1965).

Although *R. spinacidermis* resembles *R. ravidula*, also from deep water off the Cape, in the spinulose nature of the upper surface of the disc, it differs markedly in the absence of thorns around the orbits, absence of thorns along the mid-dorsal region of the back and tail, and in tooth count. The snout is not as produced as in *R. ravidula*.

Norman (1935) held that the two spinulose juveniles, reported as *R. plutonia* Garman by Barnard (1925), are specimens of *R. spinacidermis*, for despite the presence of enlarged thorns above the orbits and along the mid-line of the back and tail, the median series of thorns in the larger specimen showed signs of disappearance, i.e. a similar relationship between juveniles and adults as in *R. fullonica* (Clark, 1926). Although these specimens were not available to the present author, two almost identical specimens (SAM 22911, 24450), answering exactly to Barnard's (1925) description of *R. plutonia*, were examined. The tooth count in these specimens is 36-38 rows in the upper jaw, slightly higher than that of *R. plutonia* (32-36; Barnard, 1925), but well below the range for *R. spinacidermis*. Furthermore, the shape of the disc and length of the tail suggest a closer similarity with *R. caudaspinosa*, i.e. a similar relationship between juveniles and adults as in *R. fyllae* (Clark, 1926; Bigelow & Schroeder, 1953). However, until further material becomes available, Norman's (1935) synonymy has been tentatively accepted.

Description

Disc about 1.2-1.4 times as broad as long, its width 1.4-1.5 in total length; obtuse in front with anterior angle in front of spiracles 107°; anterior margins almost straight; posterior margins evenly convex; outer and posterior angles broadly rounded. Axis of greatest breadth 1.4-1.7 times as far from tip of snout as from posterior edge of disc. Tail with well-developed lateral folds on

TABLE 6. *R. spinacidermis*. Measurements expressed as permillage of the total length.

Character	Type	♂ (377 mm)	♀ (638.5 mm)
Total length	1 000	1 000	1 000
Disc width	684	660	701
Disc length	515	538	542
Snout to greatest disc width	307	335	315
Snout to middle of vent	466	482	487
Middle of vent to 1st dorsal origin	417	391	379
Snout length	(145)*	166	151
Preoral length	(126)*	166	148
Prenasal length	(106)*	136	114
Eye: longitudinal diameter	33	37	36
Eye and spiracle	42	46	47
Spiracle	20	—	—
Interorbital distance	45	40	36
Interspiracular distance	65	70	64
Internasal distance	83	89	79
Mouth width	83	90	87
Gill slit lengths: 1st	13	15	14
3rd	17	17	16
5th	11	13	10
Distance between inner ends of gill slits:			
1st	130	140	147
5th	89	84	91
1st dorsal fin: height	29	22	22
base length	47	50	48
2nd dorsal fin: height	27	26	19
base length	42	45	55
Interdorsal space	0	0	0

* Measurements made on damaged snout of type specimen.

posterior third; its length from middle of vent to origin of first dorsal fin 1.1–1.3 in length from middle of vent to tip of snout.

Entire upper surface of disc, and upper and lateral surfaces of tail with closely-set, fine, setiform spinules, larger and coarser on tail than elsewhere; enlarged spines or thorns absent on disc and tail in adults, but juveniles with 1–4 enlarged spines before orbit, 0–3 spines behind, and a median row of spines along back and tail, becoming reduced and finally absent in front of first dorsal origin. Enlarged spines are lost with growth (?). Ventral surface with spines on tip of snout and on tail, except on median line of distal two-thirds.

Snout pointed but not produced; its length in front of orbits 3.8–4.2 times as long as distance between orbits; its length in front of mouth 1.5–1.9 times as great as distance between nostrils. Orbits 1.6 times as long as spiracles; distance between orbits 1.0–1.3 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, extending beyond anterior extremities of pectoral rays.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril fringed. Teeth arranged in 54–60 regular rows in upper jaw, blunt with posterior cusp laterally, slightly pointed medially.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins about similar in size and shape, with broadly rounded apices; dorsal fins completely spinulose. First and second dorsals confluent.

Number of vertebrae Vtr 28; Vprd 65; VΣ 93.

Colour

Pale slate grey, becoming slightly darker towards posterior margins of pectorals, and distinctly darker on pelvics. Lower surface similarly and as deeply coloured as upper surface, with white mottling on distal region of tail.

Raja alba Lacépède, 1803

(Pl. 5 A, B; Figs 8 A, B, C)

Raja alba Lacépède, 1803: 663, pl. 20, fig. 1. Norman, 1935: 40. Fowler, 1936: 115; 1941: 365. Van Bruggen, 1965: 190. Hulley, 1966: 497, fig. 8. Wallace, 1967: 27, figs 13-15.

Raja alba: Von Bonde & Swart, 1923: 5. Smith, 1961: 66, fig. 67; 1964: 285. Thorpe, 1964: 27.

Raja marginata Lacépède, 1803: 663, pl. 20, fig. 2. Thompson, 1914: 158.

Raja marginata: Regan, 1908: 242. Gilchrist & Thompson, 1916: 285. Barnard, 1925: 65, pl. 4, fig. 1. Clark, 1926: 49, pls 28, 29, 30, 31a. Von Bonde, 1932: 33. Barnard, 1947: 26, pl. 3, figs 11, 11a.

Type

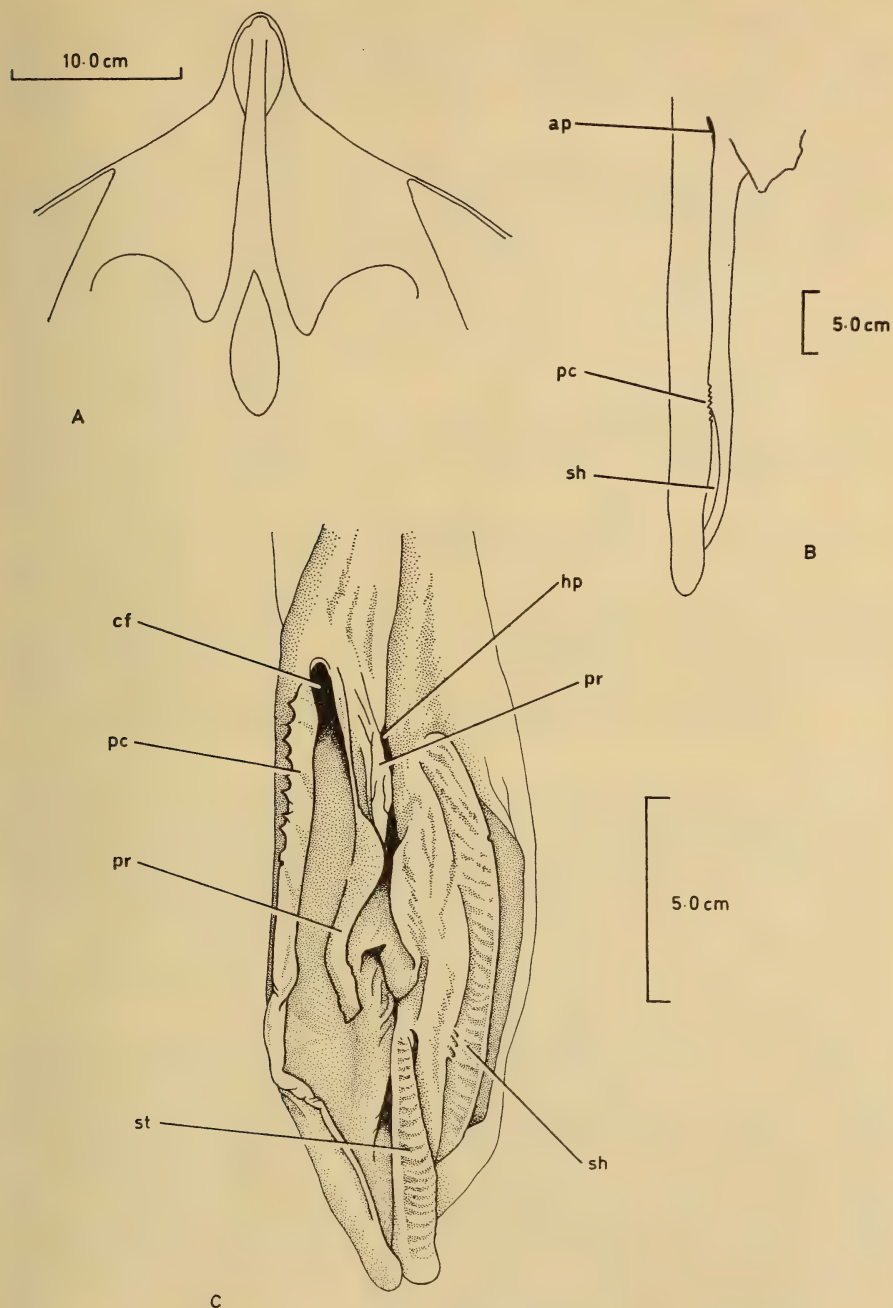
The locality of the types of *R. alba* and *R. marginata* not given in the original description.

Material

21 specimens of both sexes (286-816 mm total length), trawled from False Bay to Port Alfred in 110-183 metres. 9 specimens preserved in the collection of the South African Museum (SAM 3235, 13026, 22578, 22633, 23590, 24329, 24336).

Clark (1926) has shown that *R. marginata* is synonymous with *R. alba*, the common sparnose skate of the north-eastern Atlantic and Mediterranean. This species extends southwards from this region, along the western coasts of Morocco (Pietschmann, 1906), West Africa (Fowler, 1936) and Angola (Franca, 1959) and is reported in South Africa under the same name. Norman (1935) pointed out that the snout appears to be slightly longer in European specimens than in South African specimens, but he was unable to detect any other important difference.

The claspers of a mature male of *R. alba* (1 700 mm total length) in the collection of the Oceanographic Research Institute, Durban, have been examined (fig. 8). The present author is unable to detect a single difference between the structure of the clasper of this specimen and the description of the clasper of European specimens of *R. alba* (Leigh-Sharpe, 1924, fig. 15), and therefore holds that *R. alba* from southern Africa is identical to *R. alba* from the northern hemisphere.

FIG. 8. *Raja alba*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apopyle; cf—cleft; hp—hypopyle; pc—pecten; 'pr'—'pseudorhipidion'; sh—shield;
st—sentinel.

TABLE 7. *R. alba*. Measurements expressed as permillage of the total length. Number of specimens 21.

Character	Mean	Range
Total length	1 000	
Disc width	777	754-804
Disc length	537	511-566
Snout to greatest disc width	350	300-410
Snout to middle of vent	493	465-516
Middle of vent to 1st dorsal origin	329	314-359
Snout length	155	141-164
Preoral length	149	129-162
Prenasal length	119	103-132
Eye: longitudinal diameter	41	33-47
Eye and spiracle	57	52-61
Spiracle	25	19-35
Interorbital distance	54	49-59
Interspiracular distance	70	63-76
Internasal distance	91	84-97
Mouth width	90	81-101
Gill slit lengths: 1st	18	16-21
3rd	19	16-23
5th	12	10-14
Distance between inner ends of gill slits:		
1st	175	166-186
5th	104	96-109
1st dorsal fin: height	33	27-37
base length	60	50-66
2nd dorsal fin: height	29	20-35
base length	62	56-69
Interdorsal space	17	0-34

Description

Disc about 1.4-1.5 times as broad as long, its width 1.2-1.3 in total length, with maximum angle in front of spiracles about 105° ; anterior margins concave just behind tip of snout, convex opposite eyes and again concave opposite spiracles; outer angles pointed, posterior angles broadly rounded. Axis of greatest breadth 1.3-2.2 times as far from tip of snout as from posterior edge of disc. Tail short and broad, tapering posteriorly, with lateral folds well developed on posterior third; its length from middle of vent to first dorsal origin 1.4-1.6 in length from middle of vent to tip of snout.

Juvenile specimens with 1 thorn in front of orbit and 0-1 thorn behind. Nuchal and scapular regions and mid-line of back without thorns. 10-16 thorns along mid-line of tail, from about posterior edge of pelvic to origin of first dorsal, and 0-2 thorns in dorsal interspace. 7-17 lateral caudal thorns in a single row on each side. Otherwise dorsal surface of disc and tail smooth. Ventral surface with spinules on tip of snout, internasal region and anterior margins of disc to about level of mouth; spinules arranged in 3-4 irregular rows.

Adult specimens with a row of thorns about inner margins of orbits. Nuchal and suprascapular thorns absent. 16-30 thorns along mid-line of tail, from about posterior edge of pelvis to origin of first dorsal fin, and 0-2 thorns in dorsal interspace. A single row of 17-29 lateral caudal thorns on each side, irregularly arranged and generally uneven on the two sides. Spinules on dorsal

surface of disc on snout, rostral cartilage, anterior margins and mid-line of back. Ventral surface with spinules on snout, internasal region, anterior margins, abdomen and gill slits. Spinules on both dorsal and ventral surfaces of tail.

Snout abruptly narrowed and produced into a long, sharp point; its length in front of orbits 2.5–3.2 times as long as distance between orbits; its length in front of mouth 1.4–2.4 times as great as distance between nostrils. Orbits 1.4–2.4 times as long as spiracles; distance between orbits 1.2–1.6 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending half the distance forward from level of front of orbits towards tip of snout.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 40–45 regular rows in upper jaw, with long conical points in middle of jaw, more obtuse with shorter points laterally.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins large, similar in shape with broadly rounded apices; height of first dorsal generally slightly greater than height of second, and base of first shorter than second; interspace between dorsals distinct, 0–58% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 62–67.

Colour

Juveniles uniformly brownish, darker towards extremities of pectoral, pelvic and caudal fins. Adults typically grey to brown, with or without scattered white spots. Ventral surface of disc white, tail and margins of pectorals and pelvics brownish to black, especially in juveniles.

Raja miraletus Linnaeus, 1758

(Pl. 7 B; Figs 9 A, B, C)

Raja miraletus Linnaeus, 1758: 231. Thompson, 1914: 158. Fowler, 1936: 114; 1941: 375. Poll, 1949: 190, fig. 4; 1951: 107, fig. 53. Wallace, 1967: 31, figs 16, 17. Hulley, 1969: 137, figs 1–3.

Raja miraletus: Von Bonde & Swart, 1923: 5. Barnard, 1925: 68 (*partim*); 1947: 26. Clark, 1926: 9.

Raja ocellifera: Thompson, 1914: 158. Fowler, 1925: 193. Norman, 1935: 42. Fowler, 1941: 375. Van Bruggen, 1965: 190.

Raja ocellifera Regan, 1906: 2, pl. 2; 1908: 242. Garman, 1913: 365. Gilchrist & Thompson 1916: 286. Von Bonde & Swart, 1923: 5. Barnard, 1925: 67; 1947: 26, pl. 4, fig. 2. Von Bonde, 1933: 32. Smith, 1961: 66, pl. 3, fig. 69; 1964: 285.

? *Raja ocellifera*: Samuel, 1963: 99.

Type

The holotype of *R. ocellifera*, a male (460 mm total length) from Algoa Bay, and paratype, a female (480 mm total length) from Natal in 73 metres, in the collection of the British Museum (Natural History).

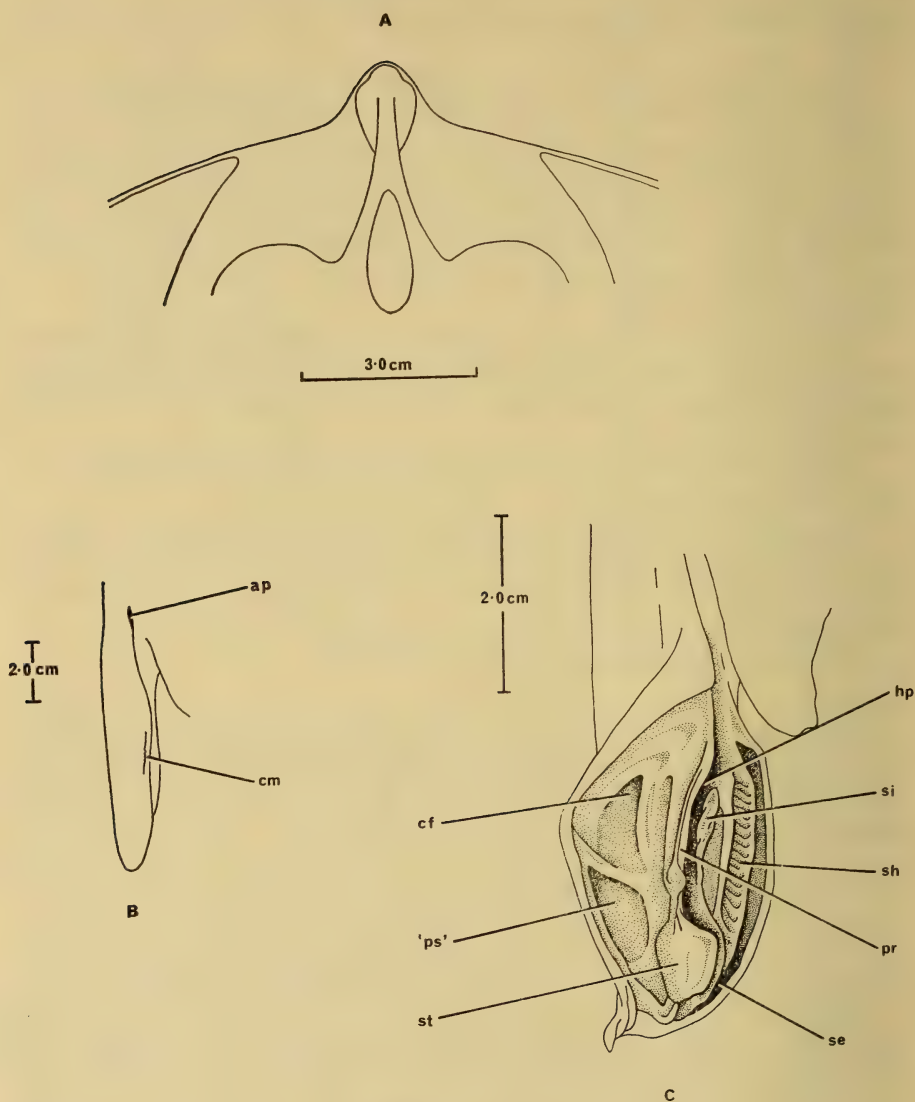


FIG. 9. *Raja miraletus*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apopyle; cf—cleft; 'ps'—'pseudosiphon' (pocket); pr—pseudorhipidion; se—sentina;
sh—shield; si—signal; st—sentinel.

Material

24 specimens of both sexes (125–510 mm total length), trawled between Cape Agulhas and Natal in 48–78 metres, and 23 specimens (272–504 mm total length) taken by R.V. *Walther Herwig* from 18°30'S to 09°40'S in 100–440 metres. 11 specimens preserved in the collection of the South African Museum (SAM 13022, 13032, 15480, 16228, 16347, 21274, 22789). Three specimens from Angola (Belgian South Atlantic Expedition, Station 15: WNW Banana) and two specimens from Sierra Leone (*Walther Herwig* Station 125/1964) also examined.

Norman (1935) pointed out that *R. ocellifera* Regan from South Africa is closely related to *R. miraletus* Linnaeus from the Mediterranean and the west coasts of Africa, but considered the two to be distinct because of differences in tail length, interorbital distance, tooth count and nature of the ocellus. After comparative morphometric studies on the two species, Wallace (1967: 33) considers 'the variation recorded to be within the limits expected of two geographically separated populations of the same species', and holds that the South African specimens should be referred to *R. miraletus*.

Hulley (1969) agrees with Norman (1935) in that the snout is longer and the interorbital distance narrower in Mediterranean specimens of *R. miraletus* than in South African specimens, but has pointed out that these differences are less noticeable in West African and Angolan specimens when compared with South African specimens. It would appear that these slight differences are of secondary importance in the systematics of this species, as is the small difference in the structure of the ocellus. Furthermore Hulley (1969) has shown that while the tail length is comparatively shorter in West African specimens, the range in number of precaudal vertebrae is the same in the two populations; also there is no difference in tooth count. Comparative anatomical studies of the claspers (Hulley, 1969) have confirmed that *R. ocellifera* is synonymous with *R. miraletus*.

The presence of a bluish-black ocellus at the base of each pectoral fin distinguishes *R. miraletus* from all other South African skates, except some juveniles of *R. clavata*. However, in *R. miraletus* the ocellus is circular (or only very slightly ovate) and consists of three distinct rings of colour, while in *R. clavata* the ocellus is markedly horizontally ovate and is usually composed of a single dark ring enclosing one or two small dark spots.

Description

Disc about 1.3–1.4 times as broad as long, its width 1.4–1.6 in total length; obtuse in front, with anterior angle in front of spiracles 110°–116°; anterior margins weakly concave behind tip of snout and gently concave between level of spiracles and outer corners; outer angles broadly rounded; posterior margins evenly convex. Axis of greatest breadth 0.9–1.3 times as far from tip of snout as from posterior edge of disc. Tail with narrow lateral folds; its length from middle of vent to origin of first dorsal fin 1.1–1.4 in length from middle of vent to tip of snout.

TABLE 8. *R. miraletus*. Measurements expressed as permillage of the total length. Number of specimens 24.

Character	Mean	Range
Total length	1 000	
Disc width	683	630-724
Disc length	511	477-529
Snout to greatest disc width	263	237-299
Snout to middle of vent	450	420-484
Middle of vent to 1st dorsal origin	350	317-387
Snout length	113	94-136
Preoral length	105	83-127
Prenasal length	84	66-99
Eye: longitudinal diameter	35	29-40
Eye and spiracle	51	45-56
Spiracle	23	19-26
Interorbital distance	43	38-48
Interspiracular distance	62	51-72
Internasal distance	80	68-87
Mouth width	82	67-88
Gill slit lengths: 1st	20	17-23
3rd	20	18-23
5th	14	11-17
Distance between inner ends of gill slits:		
1st	143	130-157
5th	74	62-89
1st dorsal fin: height	24	18-29
base length	56	47-65
2nd dorsal fin: height	24	19-27
base length	59	45-69
Interdorsal space	21	10-28

Juvenile specimens with 2 thorns in front of orbit and 1 behind; 0-2 thorns above spiracles; 3 nuchal thorns; 1 scapular thorn on each side; a row of 18-23 thorns along mid-line of back and tail from scapular region to origin of first dorsal and 0-2 thorns in dorsal interspace. Sometimes a few small spines situated semi-laterally on tail, otherwise dorsal and ventral surfaces smooth.

Older specimens show an increase in the number of thorns around orbits and on tail, but a reduction (to complete loss) of thorns along mid-line of back and on scapular region. Adults typically with 4-8 thorns around inner margins of orbits; 0-2 median nuchal thorns; a row of 12-27 thorns along mid-line of tail, from above axils of pelvics to first dorsal origin, and 1-2 thorns in dorsal interspace. Lateral rows of thorns on tail in 1-2 rows, generally unequal in number on the two sides and ranging from 8-16 thorns in semi-lateral rows and 0-13 in lateral rows. Dorsal surface with spinules on snout, anterior margins to level of spiracles, mid-line of back, and some specimens with a small group of stellate-based spines on posterior pectoral angle. Ventral surface with spines on snout, internasal region and anterior margins of disc to about level of nostrils.

Snout obtuse and not produced; its length in front of orbits 2.3-3.1 times as long as distance between orbits; its length in front of mouth 1.1-1.5 times

as great as distance between nostrils. Orbits 1.2–1.8 times as long as spiracles; distance between orbits 1.1–1.4 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending about two thirds the distance forward from level of front of orbits towards tip of snout.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 42–50 rows in upper jaw, usually with a single median point in middle of jaw, more obtuse with shorter points laterally.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in shape and about equal in size; interspace between dorsals usually small but distinct, up to 66% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 47–52. Krefft (1968a) gives the following count for *R. miraletus*: Vtr 25–29; Vprd 44–52; VΣ 70–81.

Colour

Brownish, with or without numerous small darker spots; a large blue-black ocellus at the base of each pectoral, consisting of three definite rings of colour. Ventral surface pale, with or without a small dark spot on tip of snout.

Raja clavata Linnaeus, 1758

(Pl. 6A; Figs 10 A, B, C)

Raja clavata Linnaeus, 1758: 232. Gilchrist, 1922: 7. Fowler, 1936: 110; 1941: 360. Poll, 1949: 188, fig. 3. Hulley, 1966: 497, figs 1–3. Wallace, 1967: 35, figs 18, 19.

Raia clavata: Barnard, 1925: 64, pl. 4, fig. 2; 1947: 26, pl. 4, fig. 1. Von Bonde, 1933: 32.

Raja rhizacanthus: Thompson, 1914: 158. Norman, 1935: 40. Smith & Smith, 1966: 29, fig.

Raia rhizacanthus Regan, 1906: 3, pl. 3; 1908: 242. Gilchrist & Thompson, 1916: 286. Von Bonde & Swart, 1923: 5. Smith, 1961: 67, pl. 3, fig. 71.

Raja capensis Müller & Henle, 1841: 151. Gray, 1851: 112. Bleeker, 1860: 58. Duméril, 1865: 540, pl. 12, figs 11, 12. Kner, 1865: 419. Gilchrist, 1902: 168. Thompson, 1914: 157. Gilchrist, 1921: 27.

Raia capensis: Sauvage, 1891: 510. Von Bonde & Swart, 1923: 4.

Raia barnardi: Smith, 1961: 67, pl. 3, fig. 70.

? *Raja maculata*: Bleeker, 1860: 58. Gilchrist, 1902: 168. Thompson, 1914: 157.

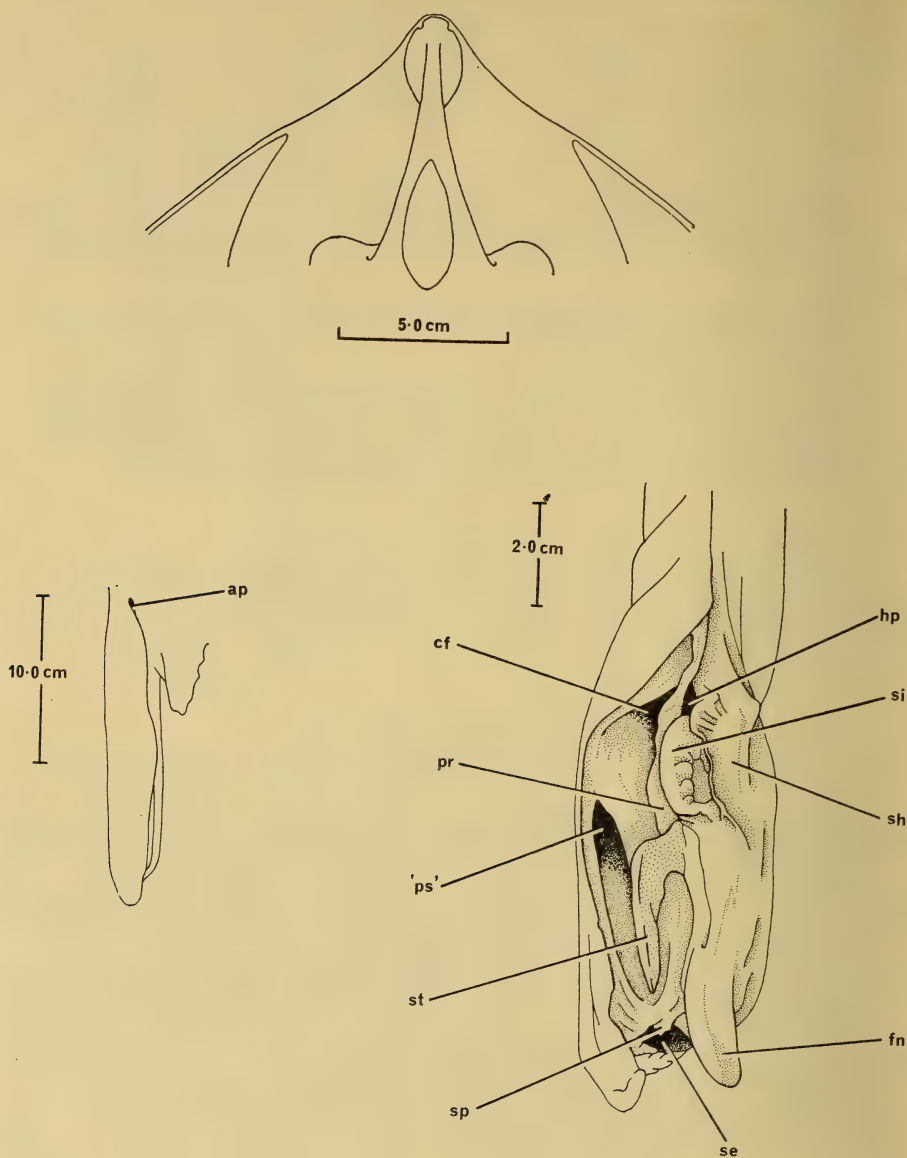
? *Raia maculata*: Barnard, 1925: 71. Von Bonde, 1933: 32.

? *Raia oculata*: Von Bonde & Swart, 1923: 4.

Types

The holotype of *R. rhizacanthus*, a juvenile male (210 mm total length), from the coast of Natal in 73 metres, in the collection of the British Museum (Natural History).

The paratype of *R. capensis* in the collection of the Muséum National d'Histoire Naturelle, Paris.

FIG. 10. *Raja clavata*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apopyle; cf—cleft; fn—funnel; hp—hypopyle; pr—pseudorhipidion; 'ps'—'pseudosiphon' (pocket); se—sentina; si—signal; sh—shield; sp—spike; st—sentinel.

Material

41 specimens of both sexes (171–790 mm total length), trawled between Cape Columbine and Algoa Bay in 55–548 metres. 30 specimens preserved in the collection of the South African Museum (SAM 22786–8, 23006–8, 24324–8, 24330–5, 24337–8, 24355–60, 24534–40).

Although the South African species *R. rhizacanthus* Regan was previously thought to be distinct from the European 'thorn-back' skate *R. clavata* Linnaeus because of differences in the spination and in the position of the vent (Norman, 1935), several authors (Barnard, 1925; Fowler, 1936, 1941) considered the two to be synonymous. Comparative anatomical studies of the claspers (Hulley, 1966) and detailed morphometric measurements (Wallace, 1967) have confirmed that the South African specimens should be referred to *R. clavata*.

R. herwigi, *R. maderensis*, *R. straeleni* and *R. clavata* form a definite sub-group of the genus *Raja* but at present the systematics of this complex of species is uncertain. *R. clavata* closely resembles *R. straeleni* in proportional dimensions, tooth count and number of vertebrae, but differs from this species in its intensity and pattern of coloration, the degree of development of the shield in the clasper glans and in its distribution. In the South Atlantic, *R. clavata* appears to have a northern limit at 26° and is replaced by *R. straeleni* over the area 22°S to 0°.

Adult specimens can easily be recognized by the spinulose nature of the dorsal surface of the disc and by the presence of enlarged buckler-like thorns, especially in females (these thorns are absent in *R. straeleni*). Adults resemble *B. smithii* in shape, but may be distinguished from this species by the number of rows of teeth in the upper jaw, the structure of the rostral cartilage and rostral appendices, and by the presence in *R. clavata* of lateral rows of thorns on the tail. It should be noted that the dental formula for *R. clavata* given by Wallace (1967) as 23–26 rows in the upper jaw, is inconsistent with previous investigations: Regan (1906) reported 36 rows in the type, Barnard (1925) gave 38–44 and Norman (1935) 36–44 rows. In the specimens examined by the author, the range was found to be 36–45, which corresponds with the 36–44 rows in European specimens (Clark, 1926). Juvenile specimens of *R. clavata* are generally smooth (sometimes with spinules along the anterior margins of the disc) and lack a lateral series of thorns on the tail. These facts, together with the lack of a produced and pointed snout and a tooth count of more than 30 rows in the upper jaw, separate this species from all other known South African skates, except *R. miraletus*. However, *R. miraletus* possesses ocelli on the dorsal surface of the disc.

Some juveniles of *R. clavata* possess a pair of ocelli at the bases of the pectoral fins, which may lead to confusion with *R. miraletus*. In *R. miraletus*, however, the ocellus is circular (or only very slightly ovate) and consists of three definite rings of colour, while in *R. clavata*, the ocellus is markedly horizontally ovate and is usually composed of a single dark ring, within which are two (sometimes one) darker spots.

TABLE 9. *R. clavata*. Measurements expressed as permillage of the total length. Number of specimens 41.

Character	Mean	Range
Total length	1 000	
Disc width	731	679-773
Disc length	529	481-569
Snout to greatest disc width	308	280-336
Snout to middle of vent	471	432-517
Middle of vent to 1st dorsal origin	349	317-390
Snout length	133	120-155
Preoral length	123	106-142
Prenasal length	102	87-119
Eye: longitudinal diameter	35	23-41
Eye and spiracle	49	45-56
Spiracle	23	19-27
Interorbital distance	47	41-52
Interspiracular distance	70	65-75
Internasal distance	84	76-92
Mouth width	82	77-91
Gill slit lengths: 1st	20	
3rd	21	
5th	14	
Distance between inner ends of gill slits:		
1st	159	135-177
5th	83	73-97
1st dorsal fin: height	29	19-39
base length	58	45-71
2nd dorsal fin: height	30	21-37
base length	60	45-76
Interdorsal space	19	0-35

Description

Disc about 1.3-1.4 times as broad as long, its width 1.3-1.5 in total length; obtuse in front, with anterior angle in front of spiracles 80° - 100° ; anterior margins weakly concave behind tip of snout and again at level of spiracles, more deeply so in males than in females; outer and posterior angles broadly rounded. Axis of greatest breadth 1.2-1.8 times as far from tip of snout as from posterior edge of disc. Tail with moderately developed lateral folds on posterior third; its length from middle of vent to origin of first dorsal fin 1.2-1.6 in length from middle of vent to tip of snout.

Juvenile specimens with 2 thorns in front of orbits and 1 behind: 1 supra-spiracular thorn and 1 pair of thorns between spiracles; 2-4 median nuchal thorns; 2 scapular thorns on each side; a row of 24-30 thorns along mid-line of back and tail from scapular region to origin of first dorsal fin; 1-2 thorns in dorsal interspace. No lateral rows of thorns on tail. Dorsal surface with spinules on snout, interorbit, anterior margins of disc and along mid-dorsal region of back and tail. Ventral surface smooth.

Older specimens show a reduction in number of preorbital, postorbital, supraspiracular, interspiracular and scapular thorns, until these disappear in the adult. Adults typically with no thorns around inner margins of orbits and above spiracles, no nuchal spines, no scapular thorns and no enlarged thorns

along the mid-line of back; a row of 19–41 thorns along mid-line of tail from above vent to origin of first dorsal fin; 1–2 thorns in dorsal interspace. A row of lateral caudal thorns on each side (sometimes two), irregularly arranged. Widely-spaced spinules on dorsal surface of snout, interorbit and mid-dorsal region of back and tail. Ventral surface spinulose along anterior margins of disc and around vent. Buckler-like thorns on dorsal and ventral surfaces of disc, especially around vent, in some specimens, particularly females.

Snout pointed but not produced; its length in front of orbits 2.6–3.4 times as long as distance between orbits; its length in front of mouth 1.3–1.7 times as great as distance between nostrils. Orbits 1.3–2.0 times as long as spiracles; distance between orbits 1.1–1.4 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; tips of pectoral fins falling short of appendices.

Mouth slightly arched; nasal curtain slightly fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 36–45 rows in upper jaw, with large cusp in sexually mature males, but blunt and flat in juveniles and females.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in shape, with broadly rounded apices; first dorsal usually slightly smaller than second; interspace between dorsals usually about 30% as long as base of first dorsal, but varying between 0% and 66%.

Number of precaudal vertebrae (Vprd) 45–53.

Colour

Colour variable, particularly in juveniles. Brownish or grey-brown, with or without numerous irregular darker and lighter spots or with larger irregular darker blotches. Juveniles generally with a dark, horizontally ovate ocellus at the base of each pectoral, consisting of a single dark ring enclosing two (sometimes one) dark spots. Ventral surface pale, margins of pectorals generally greyish, occasionally with some darker irregular patches.

Raja straeleni Poll, 1951

(Pl. 6 B; Figs 11 A, B, C)

Raja straeleni Poll, 1951: 118, fig. 54. Krefft, 1968a: 66, pl. Va.

Types

The holotype, a mature male (620 mm total length), trawled in 100–110 metres at 13°05'S, 12°46'E, in the collection of the Institut Royal des Sciences Naturelles, Brussels. 21 paratypes in the same collection.

Material

The holotype and paratypes, as well as 8 specimens trawled in 200–700 metres by R.V. *Walther Herwig* between 10°28'S and 22°03'S. Measurements taken on 16 specimens including the holotype. Material from the R.V. *Walther Herwig* located in the collection of the Institut für Seefischerei, Hamburg.

R. straeleni forms part of the *clavata*-complex of species. The systematics of this complex, which includes the species *R. clavata*, *R. herwigi*, *R. maderensis* and *R. straeleni* is as yet uncertain. In the South Atlantic, *R. straeleni* has been found in the region between the equator and about 22°S and is replaced by *R. clavata* to the south of this limit.

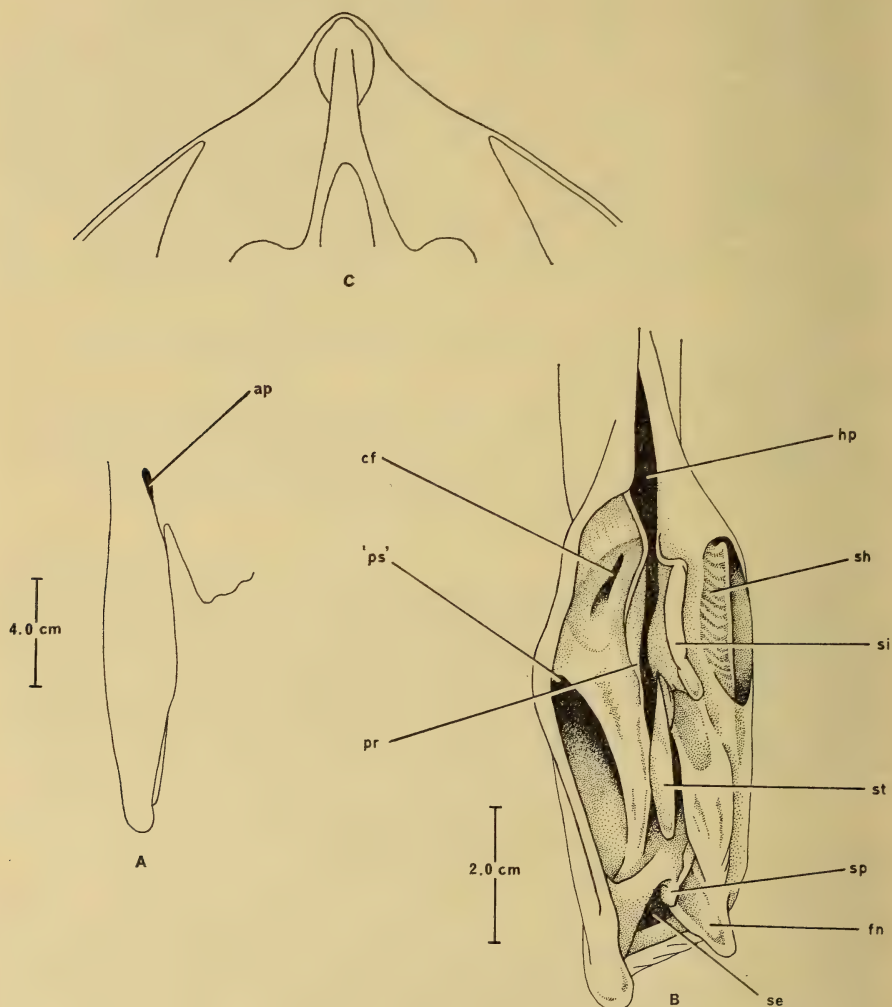


FIG. 11. *Raja straeleni*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apopyle; cf—cleft; fn—funnel; hp—hypopyle; pr—pseudorhipidion; 'ps'—'pseudosiphon' (pocket); se—sentina; sh—shield; si—signal; sp—spike; st—sentinel.

R. straeleni very closely resembles *R. clavata*, and while there are noticeable differences in colour pattern and intensity, which appear to be constant in *R. straeleni*, there is only a slight difference in the external morphology of the claspers of the two species – the shield in *R. straeleni* is more strongly developed, suggesting a difference in the degree of development of the ventral terminal cartilage. Morphometric proportions and vertebral counts are similar in the two species.

On the basis of colour pattern, the taxonomic significance of which is at present unknown, distribution and the structure of the shield, *R. straeleni* has been retained for the moment as a separate species. Detailed investigations of the skull and the nature of the clasper cartilages should elucidate this problem.

TABLE 10. *R. straeleni*. Measurements expressed as permillage of the total length. Number of specimens 16.

Character	Mean	Range
Total length	1 000	
Disc width	672	614-729
Disc length	503	471-525
Snout to greatest disc width	322	292-357
Snout to middle of vent	465	439-500
Middle of vent to 1st dorsal origin	343	326-383
Snout length	132	124-144
Preoral length	125	112-135
Prenasal length	102	93-109
Eye: longitudinal diameter	40	33-49
Eye and spiracle	55	48-60
Interorbital distance	44	40-48
Interspiracular distance	69	63-72
Internasal distance	88	84-92
Mouth width	86	81-94
Gill slit lengths: 1st	21	17-28
3rd	23	17-28
5th	16	14-22
Distance between inner ends of gill slits:		
1st	163	150-180
5th	83	69-90
1st dorsal fin: height	29	22-34
base length	61	54-70
2nd dorsal fin: height	27	23-32
base length	60	55-70
Interdorsal space	34	27-56

Description

Disc about 1.2-1.5 times as broad as long, its width 1.4-1.7 in total length; obtuse in front, with anterior angle in front of spiracles about 95°-100°; anterior margins weakly concave behind tip of snout and again at level of spiracles; outer angles rounded, posterior margins evenly convex. Axis of greatest breadth 1.5-2.0 times as far from tip of snout as from posterior edge of disc. Tail with lateral folds on posterior half; its length from middle of vent to origin of first dorsal fin 1.2-1.5 in length from middle of vent to tip of snout.

1-2 thorns in front of orbits and 1-3 behind; 0-1 thorn above each spiracle;

4-5 median nuchal thorns; 0-2 scapular thorns; a row of 20-52 thorns along mid-line of back and tail, from about axis of greatest breadth to first dorsal origin; 0-6 thorns in dorsal interspace. A few lateral thorns on anterior region of tail, becoming regularly arranged and hook-like posteriorly. Dorsal surface in males entirely covered with small spines, but in females spinules only on tip of snout, mid-dorsal region of back and tail, and anterior margins of disc. Ventral surface with spines on tip of snout and along anterior margins of disc; otherwise smooth.

Snout pointed but not produced; its length in front of orbits 2.8-3.2 times as long as distance between orbits; its length in front of mouth 1.3-1.5 times as great as distance between nostrils. Distance between orbits 0.8-1.4 times as great as length of orbit.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 36-45 (35-42: Poll, 1951) rows in upper jaw, blunt and flat in smaller specimens, but sharp-pointed in adult males.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in shape with broadly rounded apices; first dorsal usually smaller than second; interspace between dorsals 17%-104% as long as base of first dorsal.

Vertebral count: Vtr 24-28; Vprd 48-52; VΣ 73-78 (Krefft, 1968a).

Colour

Dorsal surface brown to grey with numerous dark spots on whole of disc except snout, pelvic fins and tail; spots regularly arranged. Ventral surface of disc pale or mottled grey, sometimes with a darker margin along posterior edges of pectorals and pelvics. Krefft (1968a) reports that in juveniles there is no evidence of darker spots on the dorsal surface.

Raja robertsi n.sp.

(Pl. 8 A, B; Figs 12 A, B)

Type

A juvenile male (773 mm total length), trawled west of Cape Town by R.V. *Walther Herwig* (Station No. WH 196/67: 33°51'S, 17°14'E) in 1350 metres, in the collection of the Institut für Seefischerei, Hamburg.

Material

A single specimen, the holotype.

This species forms part of the *radiata*-group, the distribution and interrelationships of which have been discussed by Krefft (1968b). The group is characterized by a lozenge-shaped disc, short tail and by the presence of a single mid-dorsal row of stout spines, extending from the nuchal region (in some species from the axils of the pelvics) to the origin of the first dorsal fin. Preliminary

examination of the claspers of this group of species has revealed the presence of a pseudosiphon in the outer dorsal wall of the clasper glans. Although the type of *R. robertsi* is a juvenile male (clasper length 61 mm), the existence of the pseudosiphon can already be detected in the still undeveloped clasper.

In the Atlantic, at least, the *radiata*-group appears to be divisible into two sub-groups: the heavily-spined species, comprising the North-South Atlantic pairs *R. radiata*—*R. doellojuradoi* and *R. hyperborea*—*R. frerichsi*; and the sub-group comprising the North Atlantic species *R. jenseni* and the South Atlantic species *R. georgiana*, in which there are no enlarged stellate-based thorns on the anterior margins and posterior angles of the pectorals. *R. robertsi* is a member of this second sub-group.

Although it resembles *R. georgiana* in tooth count and spination of the orbit, *R. robertsi* can easily be separated from this species by the characteristic dark coloration of its ventral surface. It most closely approximates to the North Atlantic species *R. jenseni* in lacking large rostral thorns and in ventral coloration, but differs markedly from this species in tooth count (56–66 rows in upper jaw in *R. jenseni* (Bigelow & Schroeder, 1953): 42 rows in *R. robertsi*), preoral length and scapular spination. Furthermore, there are fewer thorns in the mid-line of the disc and tail in *R. robertsi*.

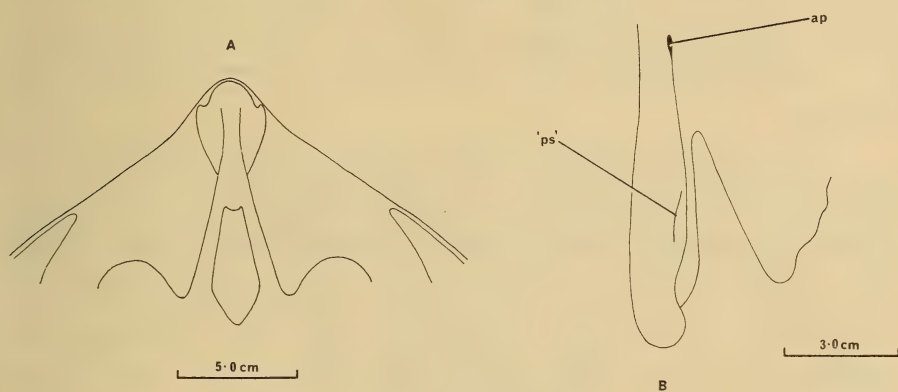


FIG. 12. *Raja robertsi*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

ap—apophysis; 'ps'—'pseudosiphon'.

In tooth count and general coloration, *R. robertsi* falls close to *R. badia* caught in 1270 fathoms in the Gulf of Panama (Garman, 1899). However, *R. badia* belongs to the heavily spined sub-group (Berg, 1911 considers it to be a possible synonym of *R. hyperborea* (Bigelow & Schroeder, 1953)) and therefore differs in the spination of the disc.

This species has been named in honour of Mr. J. Douglas Roberts, who by his kind generosity, made the study of the *Walther Herwig* material in Hamburg possible.

TABLE 11. *R. robertsi*. Measurements expressed as permillage of the total length.
A single specimen, the type (773 mm total length).

Character	Dimensions
Total length	1 000
Disc width	729
Disc length	569
Snout to greatest disc width	428
Snout to middle of vent	581
Middle of vent to 1st dorsal origin	311
Snout length	145
Preoral length	142
Prenasal length	108
Eye: longitudinal diameter	44
Eye and spiracle	63
Interorbital distance	68
Interspiracular distance	107
Internasal distance	121
Mouth width	131
Gill slit lengths: 1st	15
3rd	14
5th	11
Distance between inner ends of gill slits:	
1st	215
5th	155
1st dorsal fin: height	17
base length	45
2nd dorsal fin: height	15
base length	40
Interdorsal space	0

Description

Disc 1.3 times as broad as long, its width 1.4 in total length; obtuse in front, with anterior angle in front of spiracles 96° ; anterior margins concave just behind tip of snout and more deeply concave just posterior to level of spiracles; outer angles somewhat pointed, posterior margins almost straight. Axis of greatest breadth 3.4 times as far from tip of snout as from posterior edge of disc. Tail with fairly well developed lateral folds along its entire length; its length from middle of vent to origin of first dorsal fin 1.9 in length from middle of vent to tip of snout; its length from middle of vent to tip of tail 1.4 in length from middle of vent to tip of snout.

Spination:

Preorbital thorns	1/1
Postorbital thorns	1/1
Supraspiracular thorns	1/1
Median nuchal thorns	2
Scapular thorns	2/2

A single row of 21 (+ 1 scar) stout thorns extending from nuchal region almost to origin of first dorsal. No lateral rows of thorns on disc or tail. 1 small stellate-based spine on rostrum, no thorns on anterior margins and posterior angles of pectorals; entire upper surface of disc and tail covered with close-set spinules. Malar spines present. Ventral surface of disc and tail smooth.

Snout obtuse and not produced; its length in front of orbits 2.4 times as long as distance between orbits; its length in front of mouth 1.2 times as great as distance between nostrils. Distance between orbits 1.5 times as great as length of orbit. Rostral cartilage extending from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending half the distance forward from level of front of orbits towards tip of snout.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril fringed; no barbel-like lobe on inner edge of each nostril, but a slight fleshy fold present. Teeth arranged in 42 regular rows in upper jaw, with round bases and large, sharp posterior cusps.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsals more or less similar in size with convex anterior margins and rounded apices; first dorsal continuous with second.

Vertebral count: Vtr 32, Vprd 55, VΣ 87.

Colour

Dorsal surface of disc greyish with a few scattered darker patches over disc and tail; pelvics somewhat darker. Ventral surface of disc uniformly grey to black, tending to be darker at posterior margins of pectorals, tips of anterior lobes of pelvics and on tail. A white inverted-triangular patch in median position, with base line on level of pectoral girdle. Lower jaw and area about nostrils white.

Clasper structure

The type is an immature male, in which definite structures in the clasper glans cannot be identified. However, the claspers are of the short, spatulate variety and a pseudosiphon can be distinguished in the outer dorsal surface of the glans (fig. 12).

Raja radiata Donovan, 1807

(Pl. 7 A; Fig. 13)

Raja radiata Donovan, 1807: pl. 114.

Material

Two specimens, a male (573 mm total length) and a female (616 mm total length), trawled west of Cape Town in 548–640 metres. Both specimens preserved in the collection of the South African Museum.

This species represents a new record for the eastern South Atlantic. *R. radiata* is retained in the genus *Raja* because of the structure of the snout and a precaudal vertebral count of 58–62. It can easily be distinguished from all other South African species, except *R. robertsi*, by its extremely short tail, and differs from *R. robertsi* in the heavy spination of the disc and tail.

R. radiata forms part of the *radiata*-group of species, which are charac-

terized by their lozenge-shaped disc, short tail and single mid-dorsal row of stout thorns. The distribution and interrelationships of this group have been discussed by Krefft (1968b).

In appearance and type of spination, *R. radiata* falls into the heavily-spined sub-group of the *radiata*-complex. *R. radiata* is so closely allied to *R. doellojuradoi*, recorded from the western South Atlantic, that Bigelow & Schroeder (1953: 255) point out that 'no reliable criteria have been found to distinguish the one from the other'. Pozzi (1935, 1936) and Norman (1937) hold that in *R. radiata* the tail is longer, so that the vent is nearer to the tip of the snout than to the end of the tail; the teeth are more numerous (38-46 rows in upper jaw in *R. radiata*; 31-34 rows in *R. doellojuradoi*); there are only 2 scapular thorns; and the spines on the disc are less well developed, there being less than 10 in the mid-line of the tail posterior to the axils of the pelvics. Krefft (personal communication), in comparing six specimens of *R. radiata* from the northern Atlantic with five specimens of *R. doellojuradoi* from the western South Atlantic, has found that there is no difference in the number and distribution of the median thorns and no difference in spination except in the number of scapular thorns. Whereas in *R. radiata* two large scapular thorns exist, the third one being either vestigial or much smaller than the outer ones, in *R. doellojuradoi* the three scapular thorns are of the same size.

In the South African specimens, tooth count favours their identity with *R. radiata*, and while size at first maturity may be a questionable taxonomic character, the size of the two specimens is well above the 530 mm total length limit for *R. doellojuradoi* (Krefft, personal communication). Furthermore the rajid distribution of the Atlantic suggests that the South African fauna, which

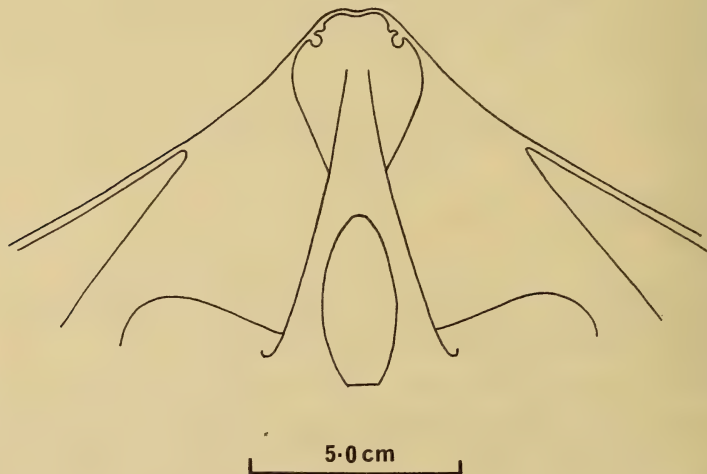


FIG. 13. *Raja radiata*.
Rostral bar and rostral appendices.

contains a number of European species (Hulley, 1966; 1969) is more closely related to that of the North Atlantic than to that of South America, i.e. a distribution following the continental slopes from north to south seems more feasible than an east-west distribution, which presupposes a crossing of the deep-sea plane or a very old 'Gondwanaland' distribution. This seems all the more likely since the generic and specific composition of the skate fauna of the eastern South Atlantic differs markedly from that of the western South Atlantic.

TABLE 12. *R. radiata*. Measurements expressed as permillage of the total length. Number of specimens 2.

Character	Male	Female
Total length	1 000	1 000
Disc width	764	771
Disc length	595	566
Snout to greatest disc width	405	360
Snout to middle of vent	597	575
Middle of vent to 1st dorsal origin	311	326
Snout length	156	149
Preoral length	152	148
Prenasal length	119	112
Eye: longitudinal diameter	42	33
Eye and spiracle	60	54
Spiracle	30	27
Interorbital distance	65	72
Interspiracular distance	101	101
Internasal	117	111
Mouth width	120	112
Gill slit lengths: 1st	13	12
3rd	17	16
5th	9	9
Distance between inner ends of gill slits:		
1st	213	205
5th	114	142
1st dorsal fin: height	23	21
base length	40	36
2nd dorsal fin: height	20	19
base length	43	41
Interdorsal space	6	8

Description

Disc about 1.2–1.3 times as broad as long, its width 1.3 in total length; obtuse in front, with anterior angle in front of spiracles about 100°; anterior margins slightly concave close behind tip of snout, otherwise almost straight; posterior angles much more broadly rounded than outer angles. Axis of greatest breadth 1.7–2.1 times as far from tip of snout as from posterior edge of disc. Tail with well-developed lateral folds beginning at axils of pelvics; its length from middle of vent to origin of first dorsal fin 1.8–1.9 in length from middle of vent to tip of snout; its length from middle of vent to tip of tail 1.4–1.5 in length from middle of vent to tip of snout.

Upper surface of disc with a median row of 18 large, conspicuous thorns on radiate bases, extending from nuchal region to origin of first dorsal; 5–6 of these anterior to axils of pelvics, and 13–14 laterally compressed thorns from

axils of pelvics to origin of first dorsal, decreasing in size posteriorly. Mid-line of back with 2-3 irregular rows of smaller thorns on stellate bases on either side of the mid-dorsal row, extending almost from the nuchal region to first dorsal origin, becoming sharper and recurved posteriorly; small spines in dorsal interspace. Anterior, median and posterior areas of pectorals with scattered thorns and smaller spines; thorns present on rostral projection, interorbit and interspiracular regions and on sides of tail; naked areas confined to anterior parts of pelvics. 1 large thorn in front of orbit and 1 behind; 1 thorn directly above each spiracle, close to postorbital thorn; 2 nuchal thorns in mid-line; 2-3 scapular thorns, the third vestigial. Ventral surface of disc and tail completely smooth.

Snout obtuse and not produced; its length in front of orbits 2.1-2.4 times as long as distance between orbits; its length in front of mouth 1.3 times as great as distance between nostrils. Orbits 1.2-1.4 times as long as spiracles; distance between orbits 1.6-2.2 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending two-thirds the distance forward from level of front of orbits towards tip of snout.

Mouth slightly arched, more so in the male than in the female; nasal curtain not fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 37-39 regular rows in upper jaw, with round bases and large, sharp posterior cusp.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsals similar in shape and about similar in size, with convex anterior margins and broadly rounded apices; interspace between dorsals 14-23% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 58-62.

Colour

Upper surface brownish-grey, with scattered irregular black blotches, especially on anterior limb of pelvic fin. Ventral surface white, with darker spots and blotches on tail and pelvics, and black spot on tip of tail.

***Raja ravidula* n. sp.**

(Pl. 9 A, B; Fig. 14)

Types

The holotype, a juvenile male (634.5 mm total length), trawled west of Cape Town by R.V. *Walther Herwig* (Station No. WH 195/76: 33°49'S, 17°13'E) in 1 000 metres, in the collection of the Institut für Seefischerei, Hamburg. The paratypes, a juvenile male (605 mm total length) and a juvenile female (631.5 mm total length), trawled west of Cape Town by R.V. *Walther Herwig* (Station No. WH 194/67: 33°47'S, 17°14'E) in 1 000 metres, in the same collection.

Material

The holotype and paratypes.

This species of deep-water skate differs from all known South African species with less than 50 rows of teeth in the upper jaw in that a median row of thorns along the back and tail is absent. In lacking a median row of thorns it approximates to the European species *R. fullonica*, which has been recorded as far south as Morocco (Murray & Hjort, 1912). However, it may be distinguished from this species by its lower tooth count (39-44 rows in upper jaw in *R. ravidula*; 58-68 rows in *R. fullonica*), lack of thorns on the tip of the rostrum and by the number and arrangement of the nuchal spines.

TABLE 13. *R. ravidula*. Measurements expressed as permillage of the total length.

Character	Type ♂	Paratype ♂	Paratype ♀
Total length	1 000	1 000	1 000
Disc width	561	578	570
Disc length	489	505	482
Snout to greatest disc width	291	314	312
Snout to middle of vent	491	496	487
Middle of vent to 1st dorsal origin	384	391	403
Snout length	138	142	148
Preoral length	149	147	155
Prenasal length	126	126	133
Eye: longitudinal diameter	38	38	38
Eye and spiracle	50	50	49
Interorbital distance	32	30	30
Interspiracular distance	72	71	71
Internasal distance	82	84	84
Mouth width	72	83	71
Gill slit lengths: 1st	14	15	13
3rd	15	18	14
5th	11	12	11
Distance between inner ends of gill slits:			
1st	132	131	138
5th	90	87	91
1st dorsal fin: height	29	31	33
base length	48	50	43
2nd dorsal fin: height	27	25	34
base length	48	45	50
Interdorsal space	8	0	0

Description

Disc about 1.1-1.2 times as broad as long, its width 1.7-1.8 in total length; maximum anterior angle in front of spiracles about 92°; anterior margins weakly concave behind tip of snout and again at level of spiracles; outer and posterior angles broadly rounded, posterior margins evenly convex. Axis of greatest breadth 1.5-1.8 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds on posterior third; its length from middle of vent to origin of first dorsal fin 1.2-1.3 in length from middle of vent to tip of snout.

No thorns along mid-line of back and tail (paratype with 1 small thorn in mid-line at about half tail length). A single series of thorns on each side of mid-line, extending from nuchal region to first dorsal origin, widely spaced on back, but, close-set and larger on tail. No thorns on rostral cartilage or between dorsal fins. Entire dorsal surface of disc covered with blunt, flat, widely-spaced asperities, tail with larger and more pointed spinules. Ventral surface of disc and tail smooth.

Snout pointed and a little produced; its length in front of orbits 4.3-4.8 times as long as distance between orbits; its length in front of mouth 1.8 times as great as distance between nostrils. Distance between orbits 1.2-1.3 in length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; tips of pectoral rays falling short of appendices.

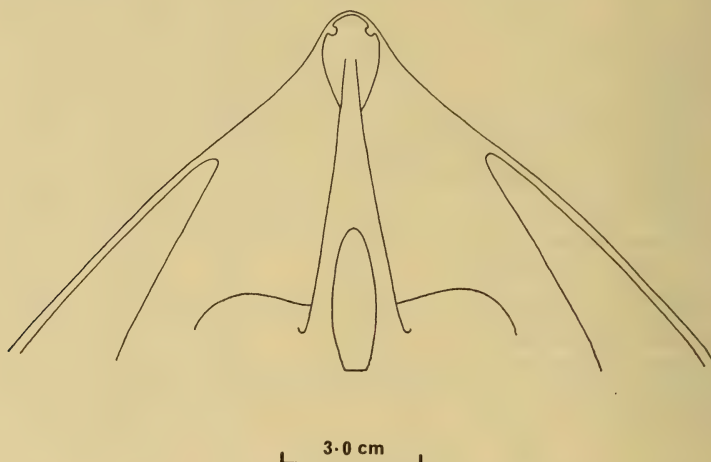


FIG. 14. *Raja ravidula*.

Rostral bar and rostral appendices.

Spination	Holotype ♂	Paratype ♂	Paratype ♀
Preorbital thorns . . .	3/3	4/4	3/3
Postorbital thorns . . .	3/3	3/3	3/3
Supraspiracular thorns . . .	1/1	1/1	1/1
Interspiracular thorns . . .	1/0	0/0	0/1
Median nuchal thorns . . .	6	6	6
Lateral nuchal thorns . . .	4/3+2	4/4	2+3/2+2
Scapular thorns . . .	2/2	0/1	3/2

Mouth slightly arched; nasal curtain slightly fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 39-44 rows in upper jaw, blunt and flat with small posterior cusp.

Anterior lobes of pelvics fin-like and continuously connected to posterior lobes along outer margin of fin.

Dorsals similar in shape, with broadly rounded apices; first dorsal usually slightly larger than second; interspace between dorsals 0%-16.5% as long as base of first dorsal.

Vertebral count	Holotype ♂	Paratype ♂	Paratype ♀
Vtr	33	30	30
Vprd.	69	69	70
VΣ	102	99	100

Colour

Dorsal surface of disc pale grey, becoming darker along posterior margins of pectorals and pelvics and at distal end of tail. Ventral surface of disc white, but darker at margins of pectorals; pelvics white with dark blotches at axils, on tip of anterior lobe and at anterior end of vent; tail greyish-brown becoming mottled with white posteriorly.

Raja dissimilis n.sp.

(Pl. 10 A, B; Figs 15 A, B, C)

Types

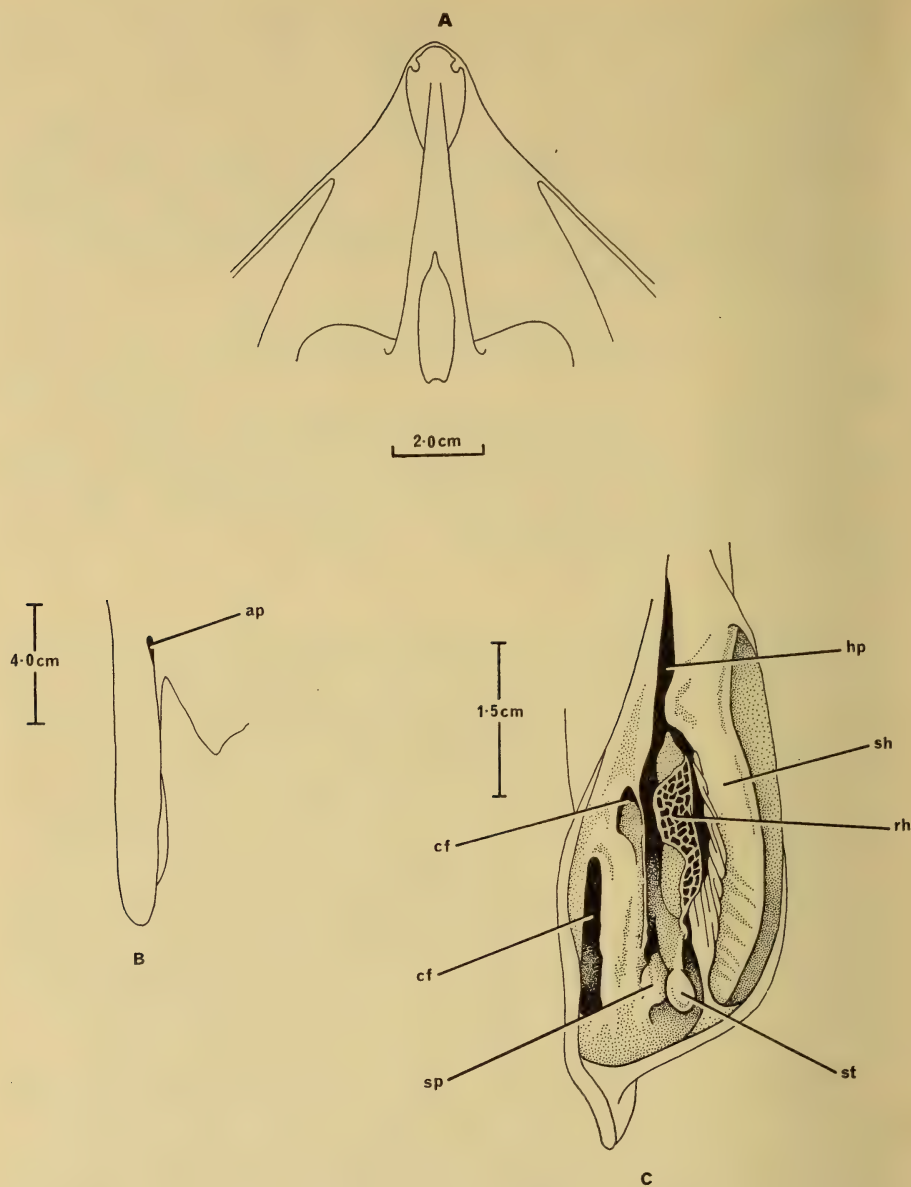
The holotype, a mature male (640 mm total length), trawled west of Cape Town by R.V. *Walther Herwig* (Station No. WH 194/67: 33°47'S, 17°14'E) in 1 000 metres, in the collection of the Institut für Seefischerei, Hamburg. Two paratypes, females (424.5 mm, 501 mm total length), taken at the same locality, in the collection in Hamburg.

Material

The type and paratypes.

R. dissimilis is unique among the southern Atlantic skates in that it shows a marked reduction in size, to eventual loss, of mid-dorsal thorns from the disc to the tail. In this respect and in tooth count, it resembles *R. senta* from the northern Atlantic, but may be distinguished from this species in that lateral rows of thorns are present on the disc and tail, and that it lacks the pale cross-barring of the tail which is typical of *R. senta* (Bigelow & Schroeder, 1953). In *R. dissimilis*, the ventral surface of the tail, from about the posterior edge of the pelvics to about the origin of the first dorsal fin, is a uniform grey colour, the tip of the tail being pale white. This peculiar tail coloration may result in confusion with *R. griseocauda* from the Patagonian-Falkland region, but in this species the tooth count is lower (30-36 rows in upper jaw in *R. griseocauda* (Norman, 1937); 37-41 rows in *R. dissimilis*) and there are major differences in ocular, scapular and caudal spination.

In morphometric dimensions, *R. dissimilis* approximates to *R. leopardus*, but it differs from this species in its lower tooth count (52-70 rows in upper jaw in *R. leopardus*), its peculiar caudal spination and in ventral coloration. Its identity is confirmed by its higher vertebral count (*R. dissimilis* Vtr 29-30; Vprd 65-69; VΣ 94-99; *R. leopardus* Vtr 31-33; Vprd 55-58; VΣ 88-90) and by the presence of two well-defined slits in the inner dorsal border of the clasper glans. By these facts, *R. dissimilis* is also distinguished from *R. confundens*, which has a similar tooth count. In *R. confundens* the vertebral count is lower (Vtr 28-30; Vprd 55-63; VΣ 84-92), and there is no distinct proximal slit in the glans. Furthermore, the snout in *R. dissimilis* is comparatively longer and the spination of the tail much less heavy than in *R. confundens*.

FIG. 15. *Raja dissimilis*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apophysis; cf—cleft; rh—rhipidion; hp—hypopyle; sh—shield; sp—spike; st—sentinel.

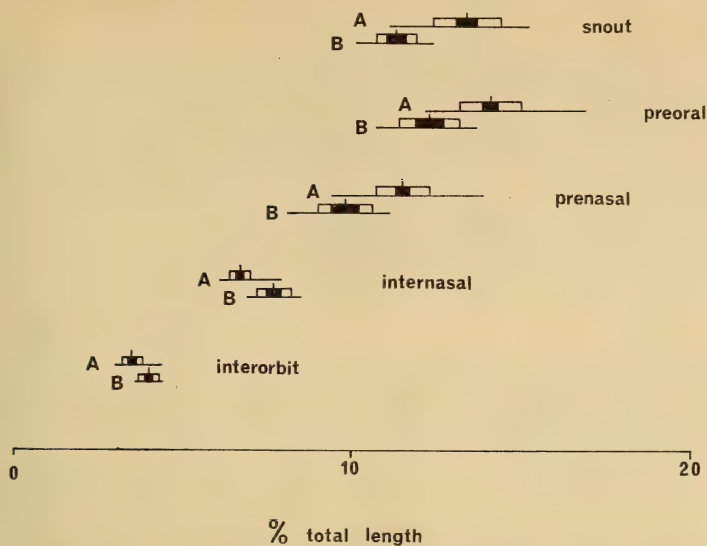


FIG. 16.

Comparison of cranial measurements of *R. confundens* and *R. leopardus* after the method of Hubbs & Hubbs (1953). In each diagram the base line represents the range of the measurement, the vertical line represents the mean, the open area represents the standard deviation on each side of the mean, and the solid area represents two standard errors on either side of the mean.

A—*Raja leopardus* B—*Raja confundens*

TABLE 14. *R. dissimilis*. Measurements expressed as permillage of the total length.

Character	Type	Paratype (501 mm)	Paratype (424.5 mm)
Total length	1 000	1 000	1 000
Disc width	609	571	593
Disc length	495	503	516
Snout to greatest disc width	308	318	312
Snout to middle of vent	506	485	502
Middle of vent to 1st dorsal origin	387	395	413
Snout length	136	143	151
Preoral length	138	150	161
Prenasal length	117	126	141
Eye: longitudinal diameter	35	39	40
Eye and spiracle	47	46	51
Interorbital distance	33	31	36
Interspiracular distance	67	66	75
Internasal distance	84	80	85
Mouth width	87	71	80
Gill slit lengths: 1st	14	14	13
3rd	19	16	16
5th	12	13	10
Distance between inner ends of gill slits:			
1st	139	140	141
5th	88	86	94
1st dorsal fin: height	31	19	31
base length	50	52	45
2nd dorsal fin: height	28	28	26
base length	43	51	41
Interdorsal space	0	0	0

Description

Disc about 1.1–1.2 times as broad as long, its width 1.6–1.8 in total length; sharp-pointed in front with anterior angle in front of spiracles 88° – 93° ; anterior margins concave just behind tip of snout and again at level of spiracles, more so in adults than in juveniles; outer and posterior angles broadly rounded. Axis of greatest breadth 1.5–1.7 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds on posterior half; its length from middle of vent to origin of first dorsal fin 1.2–1.3 in length from middle of vent to tip of snout.

<i>Spination</i>	<i>Holotype</i>	<i>Paratype</i> (424.5 mm)	<i>Paratype</i> (501 mm)
Preorbital thorns	7/8	2/1	4/4
Postorbital thorns	2/5	2/2	3/2
Supraspiracular thorns . .	1/1	1/1	1/1
Interspiracular thorns . .	1/1	1/1	1/1
Median nuchal thorns . . .	1/2	1/1	2/3
Scapular thorns	0/0	3/3	2/2

A series of 20–32 thorns on mid-line of back and tail extending from about nuchal region almost to first dorsal origin in juveniles, but only extending three-quarters of tail length in adults. Median series flanked on each side on tail (juveniles) and on back and tail (adults) by a row of 16–35/17–38 thorns. Thorns along mid-dorsal region of back and tail becoming smaller and more widely-spaced posteriorly, until in larger specimens, thorns indistinguishable from spinules in region in front of first dorsal origin. Juveniles with spinules over whole of disc and tail, no large thorns on rostral cartilage; adults with spinules on interorbit and on tail, otherwise naked, except for 2 rostral thorns. Ventral surface of disc and tail smooth.

Snout pointed and a little produced; its length in front of orbits 4.1–4.6 times as long as distance between orbits; its length in front of mouth 1.7–1.9 times as great as distance between nostrils. Distance between orbits 1.1–1.3 in length of orbit. Rostral cartilage extending from cranium as hard bar with rostral appendices fused to bar throughout their length; anterior rays of pectoral fins falling short of rostral appendices.

Mouth slightly arched, more so in adults than in juveniles; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 37–41 rows in upper jaw, blunt and flat in females, sharp-pointed in adult males.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First and second dorsals more or less similar in size and shape; first dorsal continuous with second.

<i>Vertebral count:</i>	<i>Holotype</i>	<i>Paratype</i> (424.5 mm)	<i>Paratype</i> (501 mm)
Vtr	31	29	30
Vprd	67	65	69
VΣ	98	94	99

Colour

Upper surface of disc and tail uniformly dark grey, tail mottled with white posteriorly. Ventral surface pale, posterior margins of pectorals and pelvics dark grey. Ventral surface of tail uniformly grey, becoming mottled with white posteriorly; region below dorsal fins white.

Raja confundens n.sp.

(Pl. 11 A, B; Figs 17 A, B, C)

? *Raja barnardi*: Krefft, 1968a: 61, pls IIIc, IV.

Types

The holotype, a juvenile male (378 mm total length), trawled off Cape Columbine in 620 metres, in the collection of the South African Museum (SAM 24411). The paratype, a male (478 mm total length), taken east of Cape Point in 660 metres, in the same collection (SAM 24479).

Material

22 specimens of both sexes (363–677 mm total length) including the holotype and paratype, trawled between Walvis Bay and east of Cape Point in 350–660 metres. Only 2 specimens preserved in the collection of the South African Museum (SAM 24480, PN 3), the others discarded at sea.

10 specimens trawled by R.V. *Walther Herwig* in 200–500 metres between Hondeklip Bay and Cape Frio also examined. These specimens in the collection of the Institut für Seefischerei, Hamburg.

R. confundens closely resembles the common South African west coast species *R. leopardus*, with which it is taken in trawls, but it may easily be distinguished from this species by its heavier spination pattern, particularly on the tail, and by its lower tooth count. The head in *R. confundens* is shorter and broader than in *R. leopardus* (cf. tables 15 and 16). These differences have been plotted graphically, according to the method of Hubbs & Hubbs (1953) and as there are no overlaps of standard deviations (except interorbit) the differences are significant (fig. 16). Furthermore, although the precaudal vertebral count is similar in the two species, there is a small difference in the range of trunk vertebrae. The identity of *R. confundens* is confirmed by its clasper structure.

The species identified as *R. barnardi* by Norman (1935) was distinguished from *R. leopardus* on the basis of a lower tooth count (40–42 rows in the upper jaw), which corresponds to that of *R. confundens*, and because of a single row of thorns along the back and tail. Krefft (1968a) on re-examination of the type of *R. barnardi* has shown that there are more than 50 rows of teeth in the upper jaw, while scattered lateral thorns in the juvenile type suggest the formation of lateral rows in the adult. There is no significant difference in tooth count, spination, vertebral count and proportional dimensions between *R. barnardi* and *R. leopardus*, and it is therefore held that these two species are synonymous.

Krefft (1968a) has referred four specimens obtained in the tropical east Atlantic by the *Galathea* and *Atlantide* expeditions to *R. barnardi*. These specimens are smaller than the type of *R. barnardi*, and yet possess a heavier spination

pattern and a lower tooth count. Examination of the proportional measurements and vertebral counts, suggests that these specimens should rather be referred to *R. confundens*.

The strongly re-curved thorns along the back and tail may cause *R. confundens* to be identified with *R. caudaspinosa*, but it differs markedly from this species in tail length and in tooth count.

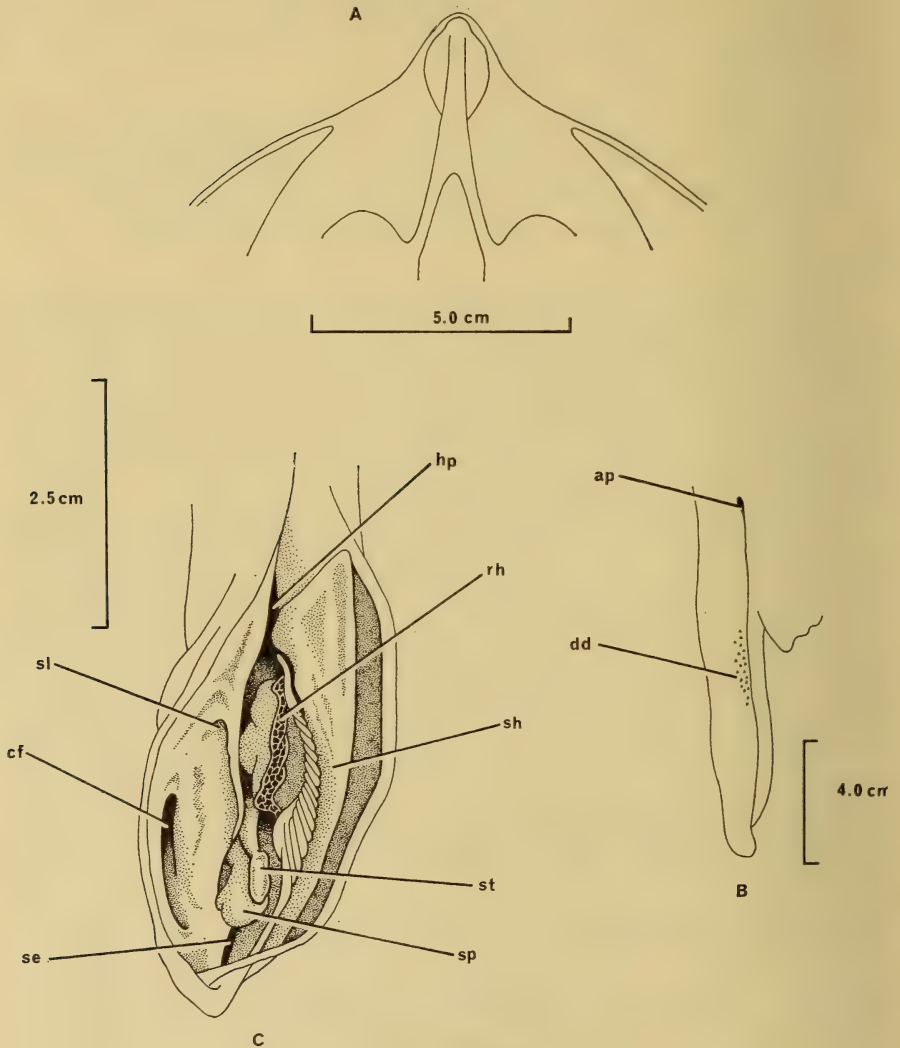


FIG. 17. *Raja confundens*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apopyle; cf—cleft; dd—dermal denticles; hp—hypopyle; rh—rhipidion; se—sentina;
sh—shield; sl—slit; sp—spike; st—sentinel.

TABLE 15. *R. confundens*. Measurements expressed as permillage of the total length. Number of specimens in the range 20.

Character	Type	Paratype	Range
Total length	1 000	1 000	
Disc width	595	596	558-668
Disc length	487	459	442-529
Snout to greatest disc width	320	280	280-340
Snout to middle of vent	444	441	444-521
Middle of vent to 1st dorsal origin	413	397	360-413
Snout length	124	107	101-124
Preoral length	136	118	107-137
Prenasal length	111	94	81-111
Eye: longitudinal diameter	37	37	36-47
Eye and spiracle	50	51	46-60
Spiracle	25	20	20-28
Interorbital distance	36	36	36-44
Interspiracular distance	61	63	57-74
Internasal distance	69	75	69-85
Mouth width	69	69	69-95
Gill slit lengths: 1st	18	17	14-24
3rd	19	18	15-25
5th	14	10	10-15
Distance between inner ends of gill slits:			
1st	148	154	148-170
5th	82	86	82-101
1st dorsal fin: height	29	23	24-44
base length	60	75	44-61
2nd dorsal fin: height	32	22	19-38
base length	60	69	41-61
Interdorsal space	0	0	0-12

Description

The figures in parentheses refer to the range of variation for 20 specimens, not including the type and paratype.

Disc about 1.2-1.3 (1.2-1.3) times as broad as long, its width 1.5-1.7 (1.5-1.8) in total length; obtuse in front, with anterior angle in front of spiracles 100° (99° - 120°); anterior margins weakly concave just behind tip of snout; outer angles broadly rounded, posterior margins evenly convex. Axis of greatest breadth 1.6-1.9 (1.4-1.8) times as far from tip of snout as from posterior edge of disc. Tail with lateral folds along posterior third; its length from middle of vent to origin of first dorsal fin 1.1 (1.1-1.4) in length from middle of vent to tip of snout.

Spination	Holotype	Paratype	Range
Circumorbital thorns	6/6	6/6	5/6-10/10
Supraspiracular thorns	1/1	1/1	1/1-1/2
Interspiracular thorns	1/1	1/2	1/1-2/2
Median nuchal thorns	4	5	2-9
Lateral nuchal thorns	2/1	4+1/3	1/2-5+2/3+5
Scapular thorns	2/2	2/2	2/2-3/3

A row of 18-21 (17-24) thorns along mid-line of back and tail, from about nuchal region or just posterior to nuchal region to origin of first dorsal. Mid-dorsal thorns flanked on each side by a single row of larger, recurved thorns,

extending almost to first dorsal; smaller hooked spines situated laterally on tail from about axils of pelvics to about half tail length; smaller flattened asperities scattered laterally over tail. Stellate-based thorns on rostral cartilage and along anterior margins of disc to outer angles. Some specimens with a patch of spines on each posterior angle of disc. Ventral surface of disc and tail smooth.

With increasing size, spination pattern becomes heavier and more complex, so that 3 rows of thorns extend from nuchal region to origin of first dorsal and a further row of semi-lateral thorns is developed on the tail, making 5 rows in this region.

Snout rounded and not produced; its length in front of orbits 3.0–3.4 (2.5–3.3) times as long as distance between orbits; its length in front of mouth 1.6–1.9 (1.4–2.0) times as great as distance between nostrils. Orbits 1.5–1.8 (1.1–2.0) times as long as spiracles; distance between orbits 1.0 (0.9–1.4) as great as length of orbit. Rostral cartilage projecting from cranium as hard bar with rostral appendices fused to bar throughout their length; tips of pectoral rays falling short of rostral appendices.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 44 rows in upper jaw (39–45), broad and flat in females and juveniles, but sharp-pointed in mature males.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First and second dorsals confluent, sometimes with a small interdorsal space; second dorsal about equal in size to first.

Vertebral count: Vtr 28–30; Vpr 55–63; VΣ 84–92.

Colour

Dorsal surface of disc and tail uniformly dark grey. Ventral surface with irregular darker patches along posterior margins of pectorals and pelvics, about vent and along tail.

Raja leopardus Von Bonde & Swart, 1923

(Pl. 12 A; Figs 18 A, B, C)

Raja leopardus Von Bonde & Swart, 1923: 7, pl. 20, fig. 2. Barnard, 1925: 74. Smith, 1961: 67, fig. 73.

Raja leopardus: Norman, 1935: 44. Fowler, 1941: 390.

Raja barnardi Norman, 1935: 43, fig. 14; Fowler, 1941: 371.

Raja quadrimaculata (non Risso) Von Bonde & Swart, 1923: 5. Barnard, 1925: 70, pl. 4, fig. 5.

Raja lintea (non Fries) Barnard, 1925: 72.

Raja naevus (non Müller & Henle) Barnard, 1925: 72.

Types

The holotype of *R. leopardus* (247 mm total length), taken in 73 metres off the coast of Natal, formerly in the collection of the Government Marine Survey; now missing. Two juvenile specimens labelled 'cotype' in the collection of the British Museum (Natural History).

The holotype of *R. barnardi*, a juvenile male (375 mm total length), trawled by the *Discovery* off the west coast of the Cape Peninsula ($34^{\circ}00'S$, $17^{\circ}58'E$) in 173–210 metres, in the collection of the British Museum (Natural History).

Material

70 specimens of both sexes (269–957 mm total length) trawled from WNW Lüderitzbucht to east of Cape Point in 300–660 metres. 26 specimens preserved

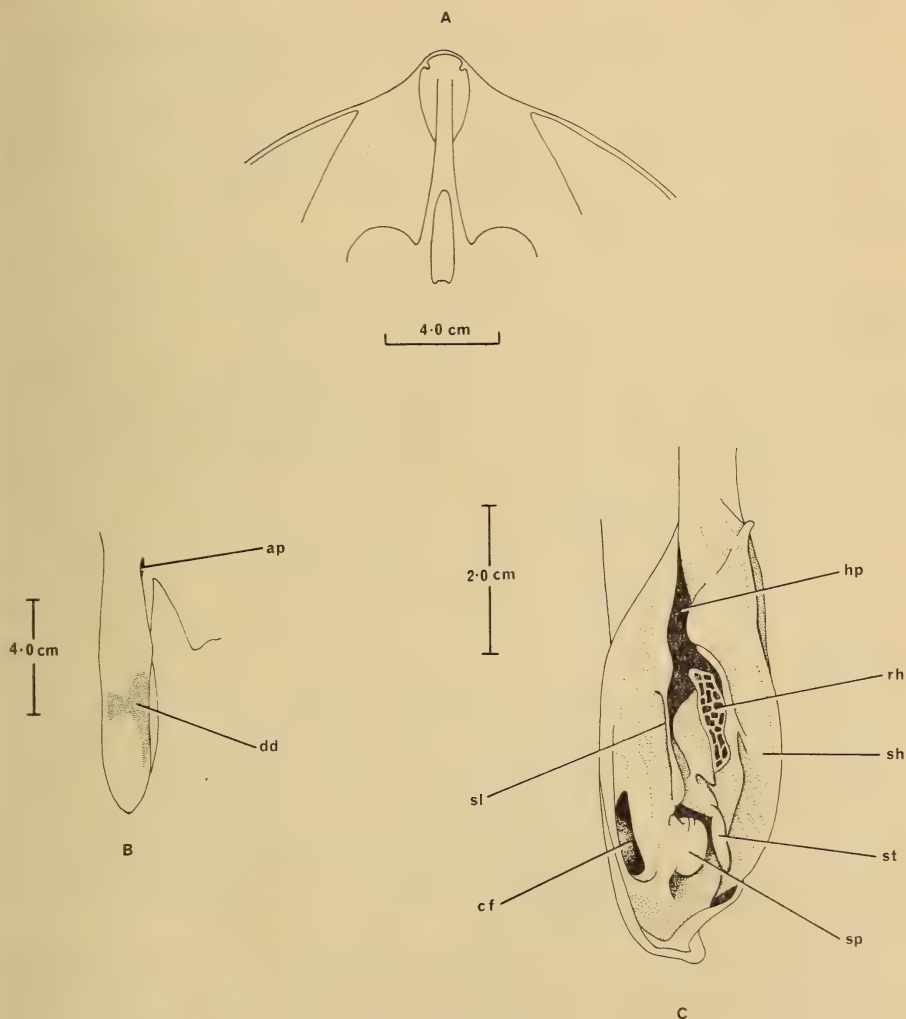


FIG. 18. *Raja leopardus*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.

ap—apophyle; cf—cleft; dd—dermal denticles; hp—hypopyle; rh—rhipidion; sh—shield; sl—slit; sp—spike; st—sentinel.

in the collection of the South African Museum (SAM 22478, 24341, 24421-2, 24453-5, 24475-7, 24481-4, 24486-92).

R. leopardus is the commonest skate taken by commercial trawlers on the west coast of South Africa. It so closely resembles *R. wallacei* in external form, that it is difficult to distinguish between the two on the basis of measurement alone. However, there appears to be differences in the structure of the clasper glans and in the precaudal vertebral count, but the two species may yet prove to be synonymous.

R. leopardus has previously been confused with the North Atlantic species *R. naevus* and *R. lintea*. Norman (1935) has pointed out the differences between *R. leopardus* and *R. naevus*. *R. leopardus* may be distinguished from *R. lintea* by having three rows of thorns along the mid-dorsal region of the back, in which the thorns in the median row on the tail are the smallest. In *R. lintea* there is always one row of spines along the back, while the median row on the tail always has the largest thorns.

The species identified as *R. barnardi* by Norman (1935) was distinguished from *R. leopardus* on the basis of a lower tooth count and the presence of a single row of spines along the back and tail. Krefft (1968a) on re-examination of the type of *R. barnardi* has found that there are more than 50 rows of teeth in the upper jaw, while the presence of scattered lateral thorns on the tail of the juvenile type suggests the formation of lateral rows in the adult. There is no significant difference in tooth count, spination, vertebral count and proportional dimensions between *R. leopardus* and *R. barnardi*, and it is therefore held that the two species are synonymous.

It should be noted that the specimens identified as *R. barnardi* by Wallace (1967) do not follow the type description for that species, and have been referred to a new species *R. wallacei*.

Description

Disc about 1.1-1.3 times as broad as long, its width 1.5-1.7 in total length; obtuse in front, with anterior angle in front of spiracles 100-110°; anterior margins concave just behind tip of snout and again at level of spiracles, more so in adult males than in females and juveniles; outer and posterior angles broadly rounded. Axis of greatest breadth 1.4-1.9 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds on posterior third; its length from middle of vent to origin of first dorsal fin 1.1-1.5 in length from middle of vent to tip of snout.

Juvenile specimens with 4-5 thorns around inner margin of orbit; 0-1 thorn above spiracles; 1 pair small thorns between spiracles; 3-5 median nuchal thorns; 1-2 scapular thorns. A row of 25-30 thorns along mid-line of back and tail from nuchal region to origin of first dorsal fin. No interdorsal thorns. Usually 3-6 small thorns situated semi-laterally on each side of tail at about level of pelvis; remainder of tail with small fine spinules. Dorsal surface with spines on tip of snout and anterior margins of disc to level of spiracles,

TABLE 16. *R. leopardus*. Measurements expressed as permillage of the total length. Number of specimens 70.

Character	Mean	Range
Total length	1 000	
Disc width	620	571-692
Disc length	510	481-543
Snout to greatest disc width	313	278-343
Snout to middle of vent	490	435-553
Middle of vent to 1st dorsal origin	374	336-419
Snout length	134	111-152
Preoral length	141	122-169
Prenasal length	115	94-139
Eye: longitudinal diameter	36	28-34
Eye and spiracle	50	46-56
Spiracle	22	17-34
Interorbital distance	35	30-44
Interspiracular distance	60	48-69
Internasal distance	67	61-79
Mouth width	75	56-93
Gill slit lengths: 1st	14	11-24
3rd	16	13-23
5th	11	7-21
Distance between inner ends of gill slits:		
1st	147	135-176
5th	84	61-110
1st dorsal fin: height	29	21-44
base length	54	41-65
2nd dorsal fin: height	29	21-41
base length	53	44-67
Interdorsal space	0	0-18

and wider spaced asperites over remainder of disc and pelvics. Ventral surface with spines on tip of snout.

Older specimens with 5-13 thorns around inner margin of each orbit and above spiracles; 1-2 pairs small inter-spiracular thorns; 4-9 median nuchal thorns, usually with 1-2 lateral rows forming a triangular patch; 2-3 scapular thorns. A median series of 19-29 widely-spaced thorns along the back and tail to origin of first dorsal, becoming reduced in size posteriorly and flanked on each side by 1 row thorns along back and 2-3 rows on tail; lateral and semi-lateral rows of thorns not greatly enlarged. Dorsal surface of disc with spines on snout, anterior margins of pectorals and sides of tail. Ventral surface with spines on tip of snout and along anterior margins.

Snout slightly pointed but not produced; its length in front of orbits 2.8-4.4 times as long as distance between orbits; its length in front of mouth 1.5-2.3 times as great as distance between nostrils. Orbits 1.0-2.1 times as long as spiracles; distance between orbits 0.9-1.4 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar with rostral appendices fused to bar throughout their length; anterior rays of pectoral fins falling short of rostral appendices.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 52-70 rows in upper jaw, with large posterior cusp in males, but blunt and flat in juveniles and females.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin. First and second dorsals confluent, sometimes with a small interdorsal space; second dorsal usually slightly smaller than first.

Vertebral count: Vtr 31–33; Vprd 55–58; VΣ 88–90.

Colour

Dorsal surface of disc uniformly brown to grey, sometimes with numerous dark spots, especially in juveniles. Norman (1935) reports the presence of a *naevus*-like ocellus at the base of each pectoral fin, particularly in adults. Ventral surface uniformly pale or with irregularly arranged darker blotches and patches on pectorals and pelvics.

Raja wallacei n.sp.

(Pl. 12 B; Figs 19 A, B)

Raja barnardi (non Norman) Wallace, 1967: 39, figs 20, 21.

Type

The holotype of *R. wallacei*, an adult male (842 mm total length), trawled at 34°10'S, 17°45'E in 292 metres, in the collection of the Oceanographic Research Institute, Durban. The paratype, a female (489 mm total length)

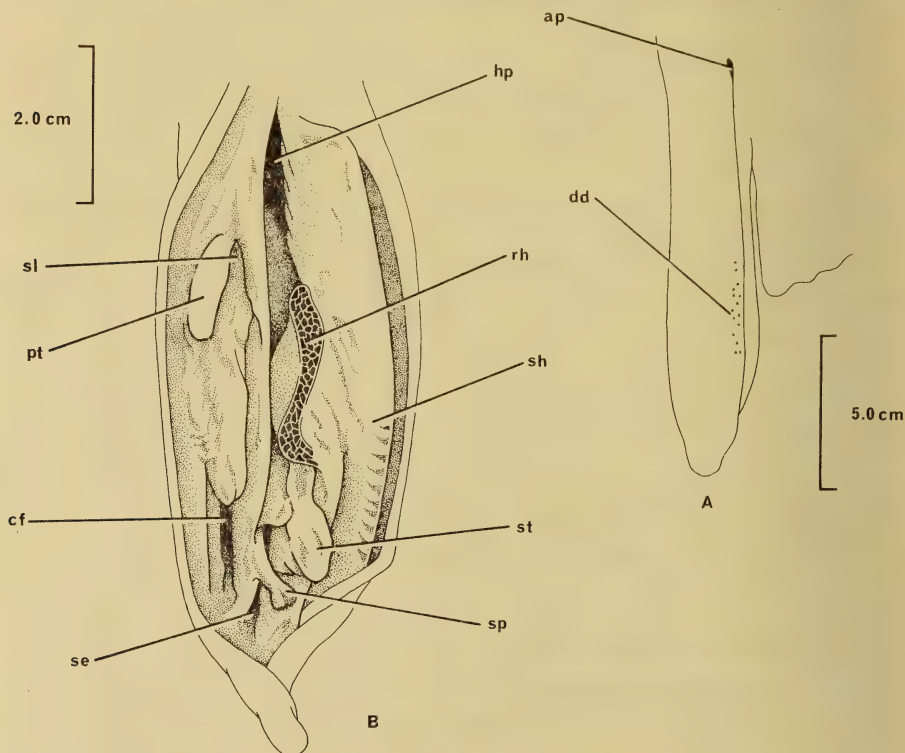


FIG. 19. *Raja wallacei*.

A: external view of right clasper from the dorsal side.

B: lateral view of right clasper, opened to show structural features of the clasper glans.

ap—apophyle; cf—cleft; dd—dermal denticles; hp—hypopyle; pt—promontory; rh—rhipidion; se—sentina; sh—shield; sl—slit; sp—spike; st—sentinel.

taken SE Durban Bluff also in the same collection.

Material

The holotype and paratype. Wallace (1967) has examined 20 specimens.

Wallace (1967) confused this species with *R. barnardi*, which was taken at the same locality. Comparison of the types of *R. wallacei* with *R. barnardi* has revealed that in *R. wallacei* the precaudal vertebral count is higher, the snout shorter, the interorbital distance greater than in *R. barnardi*. It should be noted *R. barnardi* is now held to be synonymous with *R. leopardus*.

R. wallacei closely resembles the common west coast skate *R. leopardus*, but may be distinguished from it by its greater number of precaudal vertebrae. Furthermore there are slight differences in the structure of the clasper glans. So closely are these two species related, however, that on the basis of measurement alone it is difficult to separate the one from the other. They may yet prove to be synonymous. *R. wallacei* seems to be characterized by the presence of dark blotches on the tip of each pelvic fin.

Although the holotype of *R. wallacei* was taken in Cape waters, the present author has not recorded this species during the survey. The species would seem to occur along the whole of the coastal region from the Cape to north of the Limpopo River mouth (Wallace, 1967).

TABLE 17. *R. wallacei*. Measurements expressed as permillage of the total length.

Character	Type (B 155)	Paratype (B 126)
Total length	1 000	1 000
Disc width	625	557
Disc length	494	466
Snout to greatest disc width	289	286
Snout to middle of vent	472	448
Middle of vent to 1st dorsal origin	400	413
Snout length	96	112
Preoral length	102	124
Prenasal length	73	99
Eye: longitudinal diameter	36	40
Eye and spiracle	55	56
Spiracle	25	21
Interorbital distance	42	37
Interspiracular distance	62	62
Internasal distance	69	70
Mouth width	82	76
Gill slit lengths: 1st	20	14
3rd	22	17
5th	15	13
Distance between inner ends of gill slits:		
1st	158	142
5th	88	86
1st dorsal fin: height	37	29
base length	53	61
2nd dorsal fin: height	27	27
base length	51	57
Interdorsal space	20	2

Description

Disc about 1.2–1.3 times as broad as long, its width 1.6–1.8 in total length; obtuse in front with maximum angle in front of spiracles about 110° ; anterior margins concave just behind tip of snout and again at level of spiracles; outer and posterior angles broadly rounded, posterior margins slightly convex. Axis of greatest breadth 1.4–1.6 times as far from tip of snout as from posterior edge of disc. Tail with narrow lateral folds; its length from middle of vent to origin of first dorsal fin 1.1–1.2 in length from middle of vent to tip of snout; its length from middle of vent to tip of tail 1.1–1.3 times as long as distance from middle of vent to tip of snout.

<i>Spination</i>	<i>Holotype</i>	<i>Paratype</i>
Circumorbital thorns	8/10	7/8
Supraspiracular thorns	2/3	2/3
Interspiracular thorns	0/0	1/1
Median nuchal thorns	1	7
Lateral nuchal thorns	1/1	4/4
Scapular thorns	0/0	1/2

No median row of thorns in holotype, but paratype with 34 thorns along mid-line of back and tail from about nuchal region to first dorsal origin; no thorns in dorsal interspace. Median row (or mid-line) flanked on each side by a single row of thorns from about nuchal region to axils of pelvics, increasing to two rows on each side from axils to level of interdorsal space. Dorsal surface with spines on tip of snout, along anterior margins of disc to outer angles, and on tail. Ventral surface with spinules on tip of snout and anterior margins of disc to level of mouth. Otherwise smooth.

Snout not produced, but with short terminal projection; its length in front of orbits 2.3–3.1 times as long as distance between orbits; its length in front of mouth 1.5–1.8 times as great as distance between nostrils. Orbits 1.5–1.9 times as long as spiracles; distance between orbits 0.9–1.2 times as great as length of orbit.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 59–67 regular rows in upper jaw, with round bases and sharp posterior cusp.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First dorsal larger than second and separated from it by a small but definite space; interspace between dorsals about 39% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 70.

Colour

Upper surface uniformly brown with scattered, irregular lighter spots. *Naevus*-like ocellus at base of each pectoral. Lower surface pale, with a single, dark blotch on tip of anterior lobe of pelvic fin.

Bathyraja smithii (Müller & Henle, 1841)

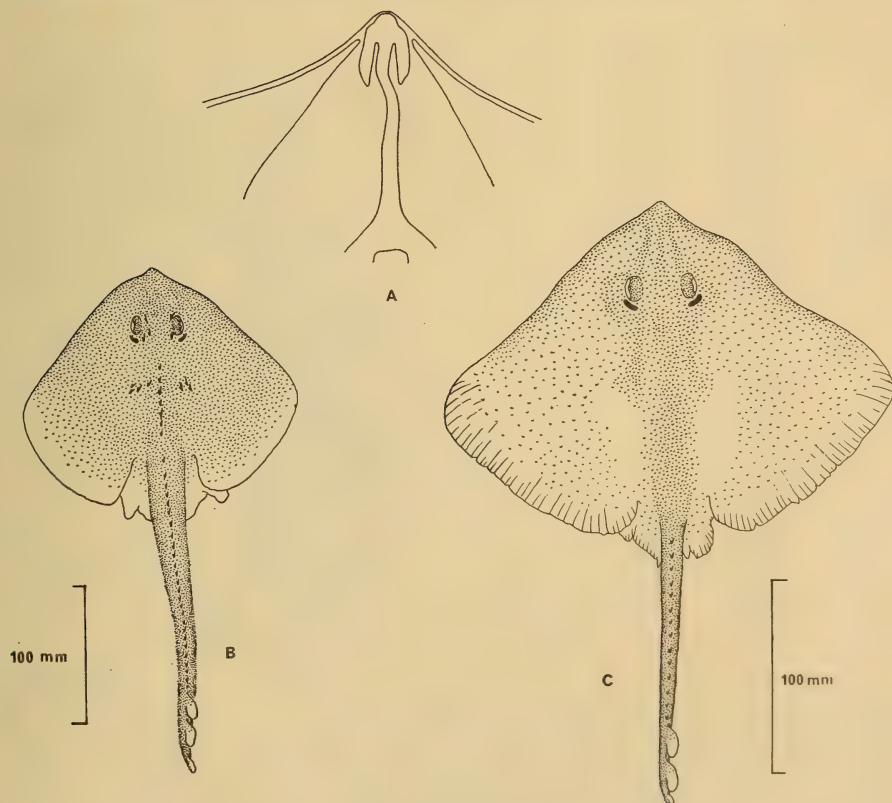
(Pl. 13; Figs 20 A, B, C; 21 A, B)

Raja smithii Müller & Henle, 1841: 150, pl. 49, fig. 1. Gray, 1851: 112. Bleeker, 1860: 58.

Duméril, 1865: 553. Günther, 1870: 467. Gilchrist, 1902: 168. Thompson, 1914: 159.

Raja smithi: Norman, 1935: 41. Fowler, 1941: 364.*Raia smithii*: Garman, 1913: 366. Von Bonde & Swart, 1923: 5.*Raia smithi*: Barnard, 1925: 66, pl. 4, fig. 4.non *Raia smithi*: Smith, 1961: 66, non pl. 3, fig. 68 (= *C. parcomaculata*).*Raja eatonii* Günther, 1876: 390; 1879: 166.*Raja eatoni* Günther, 1880: 15.*Raia eatonii*: Garman, 1913: 365.*Types*

The holotype of *R. eatonii*, a male (26.5 in. (673 mm) total length), from Royal Sound, and holotype of *R. smithii*, a dried skin, from South Africa, in the British Museum (Natural History). A mature male specimen, labelled type of *R. smithii*, from the Bosphorus, in the Muséum National des Sciences Naturelles, Paris, does not belong to this species and should be referred to *R. clavata*.

FIG. 20. *Bathyraja smithii*.

A: rostral bar and rostral appendices.

B, C: dorsal view of immature males, showing variation in spination.

Material

10 specimens of both sexes (309–1 141 mm total length), trawled east of Cape Point in 658–868 metres. 7 specimens preserved in the collection of the South African Museum (SAM 24473, 15666).

Although previously included in the genus *Raja*, this species should now be referred to the genus *Bathyraja* because of the nature of the rostral bar and rostral appendices, the number of precaudal vertebrae, and the lack of a shield in the clasper glans. Ishiyama & Hubbs (1968) also define the genus by the presence of a pseudosiphon in the clasper glans, but this is present in species of the *radiata*-group, and suggest that the genus *Bathyraja* is restricted to the Pacific. However, Dr. G. Krefft (personal communication) suggests that *Bathyraja* is a bipolar, antitropical genus.

B. smithii is most easily distinguished from all other known South African species by its low tooth count (less than 30 rows in the upper jaw) and by the lack of lateral rows of thorns on the tail. Adults resemble some specimens of *R. clavata* in shape, but differ in tooth count and spination. It should be noted

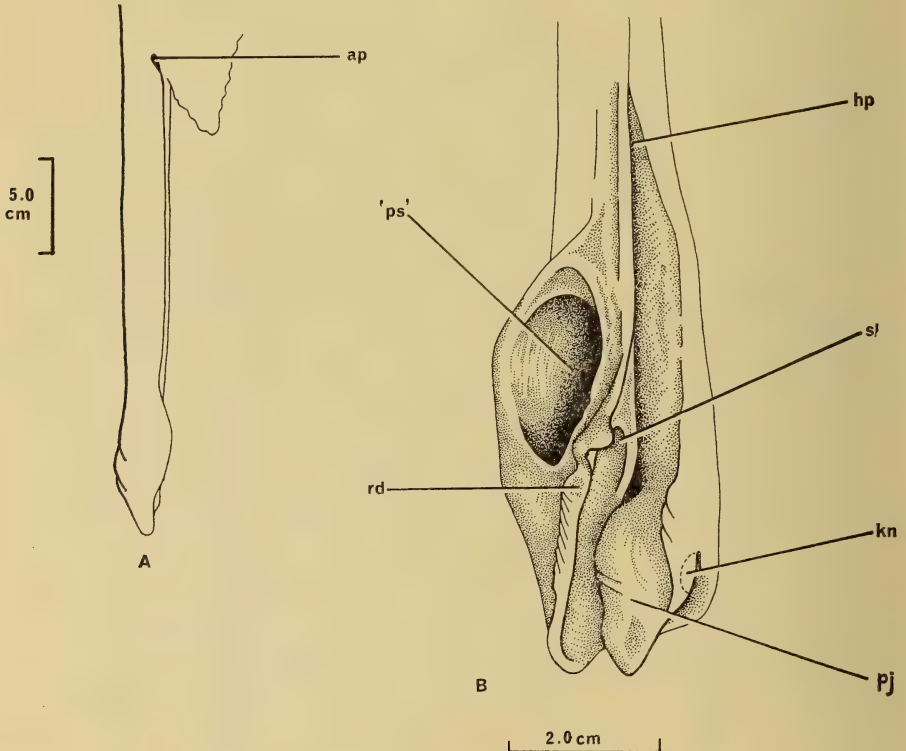


FIG. 21. *Bathyraja smithii*.

A: external view of right clasper from the dorsal side.

B: lateral view of right clasper, opened to show structural features of the glans.

ap—apopyle; hp—hypopyle; kn—knife; pj—projection; rd—ridge; 'ps'—'pseudosiphon'; sl—slit.

that Wallace (1967) gives a tooth count of 23–26 rows for *R. clavata*. This is inconsistent with previous work and with the investigations of this paper.

The dorsal surface of the disc of *B. smithii* is devoid of large thorns, except in juvenile specimens, which resemble *R. spinacidermis*. However, *R. spinacidermis* has a higher tooth count. The smoky-black borders to the ventral margins of the pectoral and pelvic fins may lead to confusion with *R. alba*, but this species can easily be distinguished by its produced and pointed snout.

Although Günther (1879) and Garman (1913) consider *R. eatonii* to be closely allied to *B. smithii*, and Barnard (1925) regards *R. eatonii* as a sub-species, Norman (1935) holds the two to be distinct on the basis of differences in spination and because of a longer snout in *R. eatonii*. Preliminary external examination of the claspers of the type of *R. eatonii*, has led me to synonymise the two species, until an examination of the clasper cartilages can be made.

TABLE 18. *B. smithii*. Measurements expressed as permillage of the total length. Number of specimens 10.

Character	Mean	Range
Total length	1 000	
Disc width	708	680–745
Disc length	529	513–544
Snout to greatest disc width	324	302–338
Snout to middle of vent	517	498–543
Middle of vent to 1st dorsal origin	355	335–376
Snout length	121	97–134
Preoral length	115	105–131
Prenasal length	89	82–99
Eye: longitudinal diameter	33	29–47
Eye and spiracle	49	40–57
Spiracle	26	19–30
Interorbital distance	56	49–61
Interspiracular distance	79	75–84
Internasal distance	91	84–98
Mouth width	86	78–93
Gill slit lengths: 1st	14	12–18
3rd	16	13–17
5th	14	12–18
Distance between inner ends of gill slits:		
1st	180	171–190
5th	122	109–136
1st dorsal fin: height	21	14–29
base length	38	32–50
2nd dorsal fin: height	20	17–28
base length	36	28–44
Interdorsal space	14	7–22

Description

Disc about 1.3–1.4 times as broad as long, its width 1.3–1.5 in total length; obtuse in front, with anterior angle in front of spiracles 90° – 100° : anterior margins weakly concave posterior to snout in juveniles, but more sinuous in adults and particularly concave at level of spiracles in mature males; posterior and outer angles broadly rounded. Axis of greatest breadth 1.2–1.7 times as far from tip of snout as from posterior edge of disc. Tail with moderately

TABLE 19. Location and collection numbers of South African rajid material.

<i>Species</i>	<i>Institution</i>	<i>Type</i>	<i>Coll. No.</i>
<i>C. parcomaculata</i>	B.M.(N.H.)	paratype	1935.7.14.1
<i>R. albalinea</i>	B.M.(N.H.)	paratype	1935.7.14.4
<i>R. spinacidermis</i>	B.M.(N.H.)	holotype	1935.7.19.7
<i>R. ocellifera</i>	B.M.(N.H.)	syntypes	1895.12.27.14 1905.6.8.14
<i>R. rhizacanthus</i>	B.M.(N.H.)	holotype	1905.6.8.13
<i>R. leopardus</i>	B.M.(N.H.)	2 'cotypes'	1935.7.14.3
<i>R. barnardi</i>	B.M.(N.H.)	holotype	1935.5.2.65
<i>B. smithii</i>	B.M.(N.H.)	holotype	1953.8.10.1
<i>B. eatonii</i>	B.M.(N.H.)	holotype	1876.3.23.21
<i>R. pullopunctata</i>	J.L.B.S.	holotype	—
		paratype	—
<i>C. triangularis</i>	J.L.B.S.	holotype	—
		paratype	—
<i>R. campbelli</i>	O.R.I.	holotype	B 804
		paratype	B 859
<i>R. wallacei</i>	O.R.I.	holotype	B 155
		paratype	B 126
<i>R. stenorynchus</i>	O.R.I.	holotype	B 186
<i>R. springeri</i>	O.R.I.	holotype	B 909
		paratype	B 185
<i>R. lanceorostrata</i>	O.R.I.	holotype	B 869
		paratype	B 868
<i>R. doutrei</i>	M.N.H.N.	holotype	59, 41
<i>R. capensis</i>	M.N.H.N.	paratype	1333
<i>R. straeleni</i>	I.R.S.N.	holotype	I.G. 16808; 99
		20 paratypes	I.G. 16808; 100-107
<i>R. robertsi</i>	I.S.H.	holotype	54/67
<i>R. ravidula</i>	I.S.H.	holotype	50/67
		2 paratypes	47a, b/67
<i>R. dissimilis</i>	I.S.H.	holotype	46a/67
		2 paratypes	46b, c/67
<i>R. confundens</i>	S.A.M.	holotype	24411
		paratype	24479

B.M.(N.H.) — British Museum (Natural History), London.

J.L.B.S. — J.L.B. Smith Institute of Ichthyology, Grahamstown.

O.R.I. — Oceanographic Research Institute, Durban.

M.N.H.N. — Muséum National d'Histoire Naturelle, Paris.

I.R.S.N. — Institut Royal des Sciences Naturelles, Brussels.

I.S.H. — Institut für Seefischerei, Hamburg.

S.A.M. — South African Museum, Cape Town.

wide lateral folds; its length from middle of vent to origin of first dorsal fin 1.3-1.6 in length from middle of vent to tip of snout.

Juveniles with 1 thorn in front of orbit and 1-2 behind; 2 median nuchal spines; 3-4 scapular thorns; a row of about 30 thorns along mid-line of back and tail from nuchal region to first dorsal origin; 1 thorn in dorsal interspace. Entire upper surface of disc and tail with widely-spaced spinules. Ventral surface smooth.

Larger specimens with ocular, nuchal and scapular thorns absent; 14-19 large thorns along mid-line of tail from above vent to origin of first dorsal fin;

0-1 thorns in dorsal interspace. Dorsal surface of disc and tail spinulose, but no lateral rows of thorns on tail. Ventral surface smooth.

Snout obtuse; its length in front of orbits 2.0-2.6 times as long as distance between orbits; its length in front of mouth 1.1-1.4 times as great as distance between nostrils. Orbits 1.0-1.4 times as long as spiracles; distance between orbits 1.5-1.9 times as great as length of orbit.

Rostral cartilage elongate with delicate, slender bar, extending to tip of snout without a segment; rostral appendix attached to extremity of rostral bar on each side, with distal part free from lateral sides of rostral cartilage; radial cartilages of pectorals extending anteriorly almost to rostral appendices.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril heavily fringed. Teeth with a single large cusp, arranged in 24-28 regular rows in upper jaw.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in shape and about equal in size, with convex anterior margins and broadly rounded apices; interspace between dorsals 22-40% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 68-71.

Colour

Dorsal surface more or less uniformly greyish or brownish in preserved specimens, sometimes with small white spots. Ventral surface white, with black blotches between gill slits and around vent; anterior margins of pectorals narrowly and posterior margins of pectorals and pelvics broadly coloured black; ventral surface of tail smoky-black.

SUMMARY

This paper consists of a systematic revision at the species level of the Rajidae of the west and south coasts of southern Africa. Five new species are described, three of which are known only from deep water, while two species are recorded for the first time in the South Atlantic. Keys to the southern African rajid fauna are given.

Natural relationships between the species are evident, suggesting a regrouping of the *Raja* species at the generic or sub-generic level. The significance of these relationships will be dealt with in a later paper.

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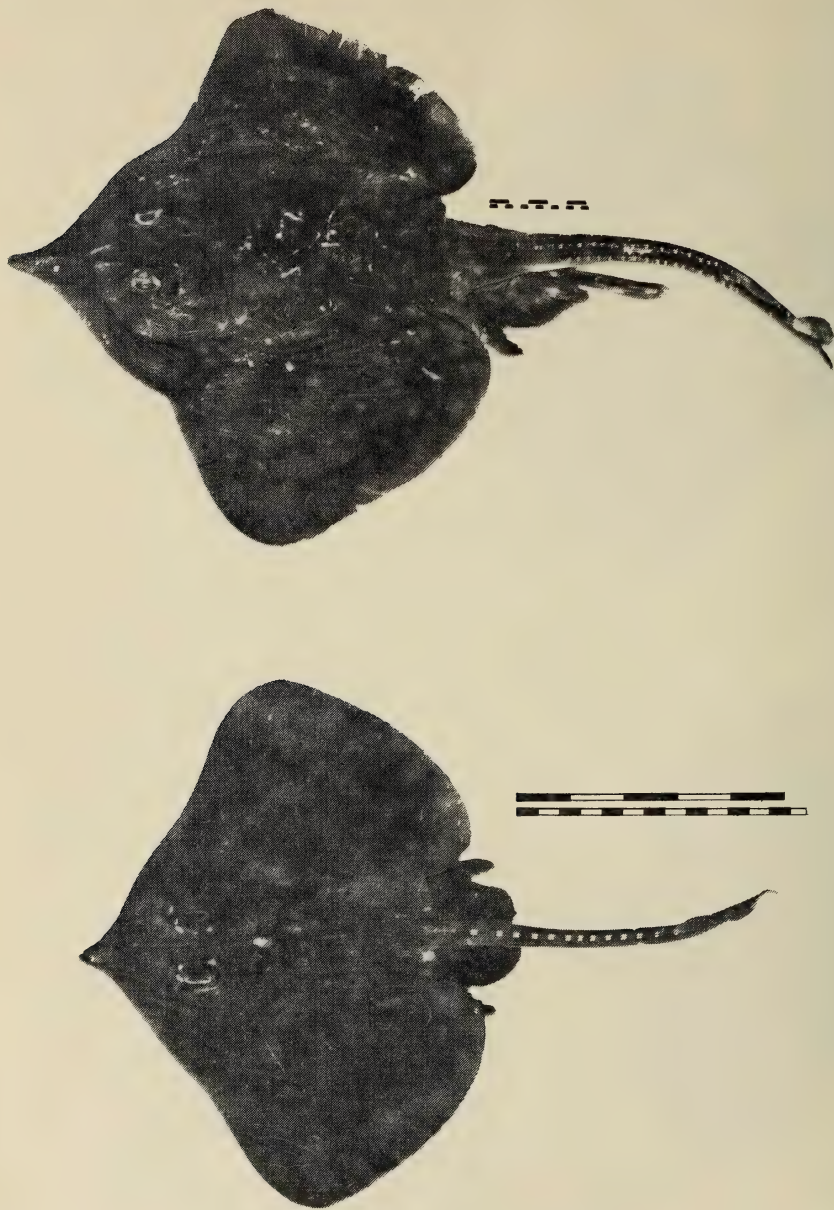
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A **B**

A. *C. parcomaculata* (female). Dorsal view. Scale in cm and in. B. *B. R. doutrei* (male; claspers and tip of pelvic fins removed). Dorsal view. Scale in cm and in.



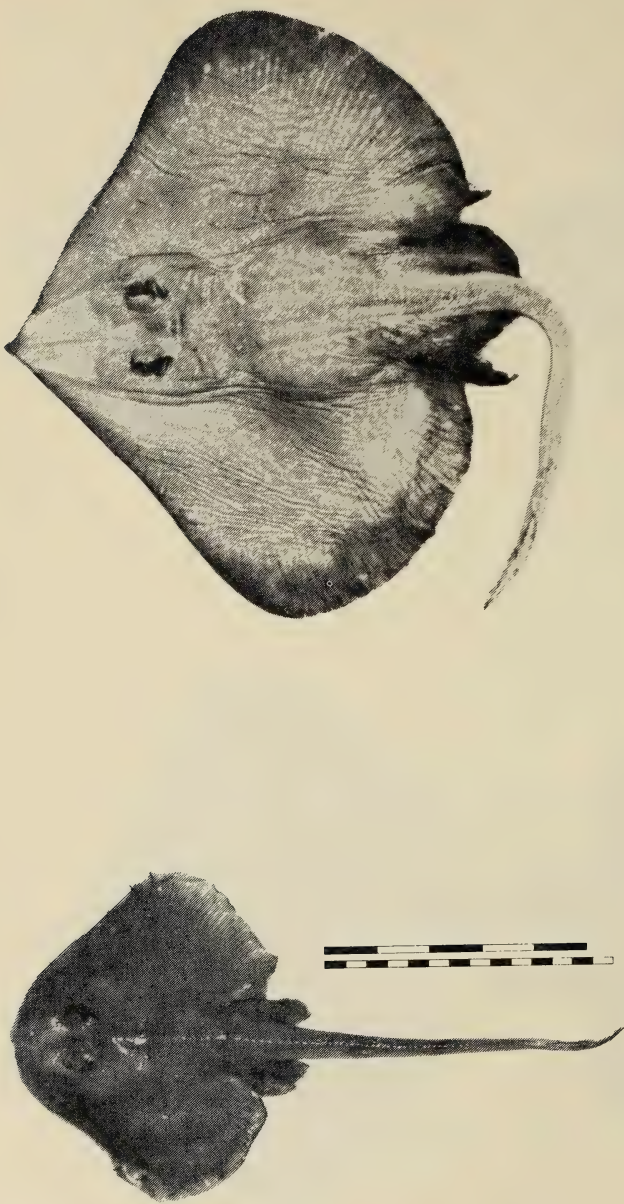
B

A

A. *R. pullopunctata* (juvenile male). Dorsal view. Scale in cm and in. B. *R. pullopunctata* (male; right pelvic fin and clasper removed). Dorsal view. Scale in cm and in.



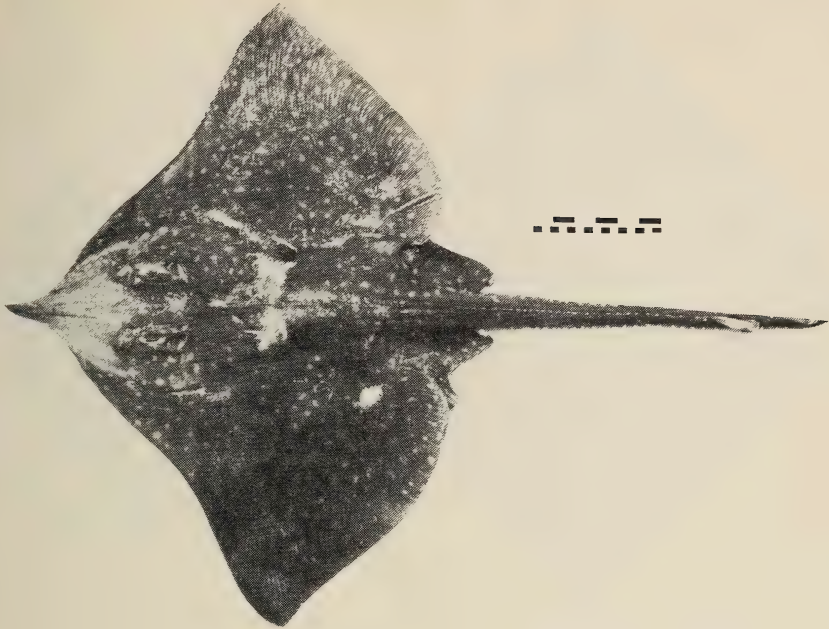
A. *R. caudaspinosa* (male). Dorsal view. Scale in cm and in. B. *R. caudaspinosa* (female). Dorsal view. Scale in cm and in.



A

B

A. ? *R. spinacidermis* (juvenile). Dorsal view. Scale in cm and in. B. *R. spinacidermis* (adolescent). Dorsal view.



B

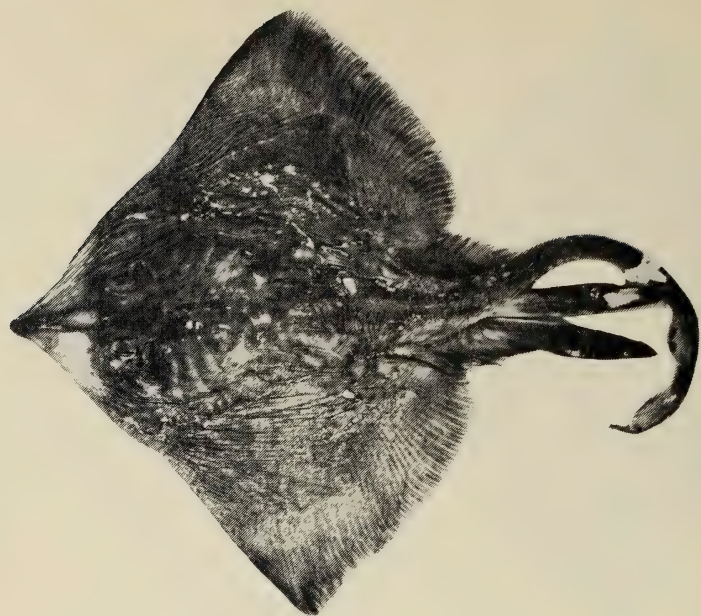


A

A. R. alba (juvenile male). Dorsal view. Scale in cm and in. *B. R. alba* (male). Dorsal view. Scale in cm and in.

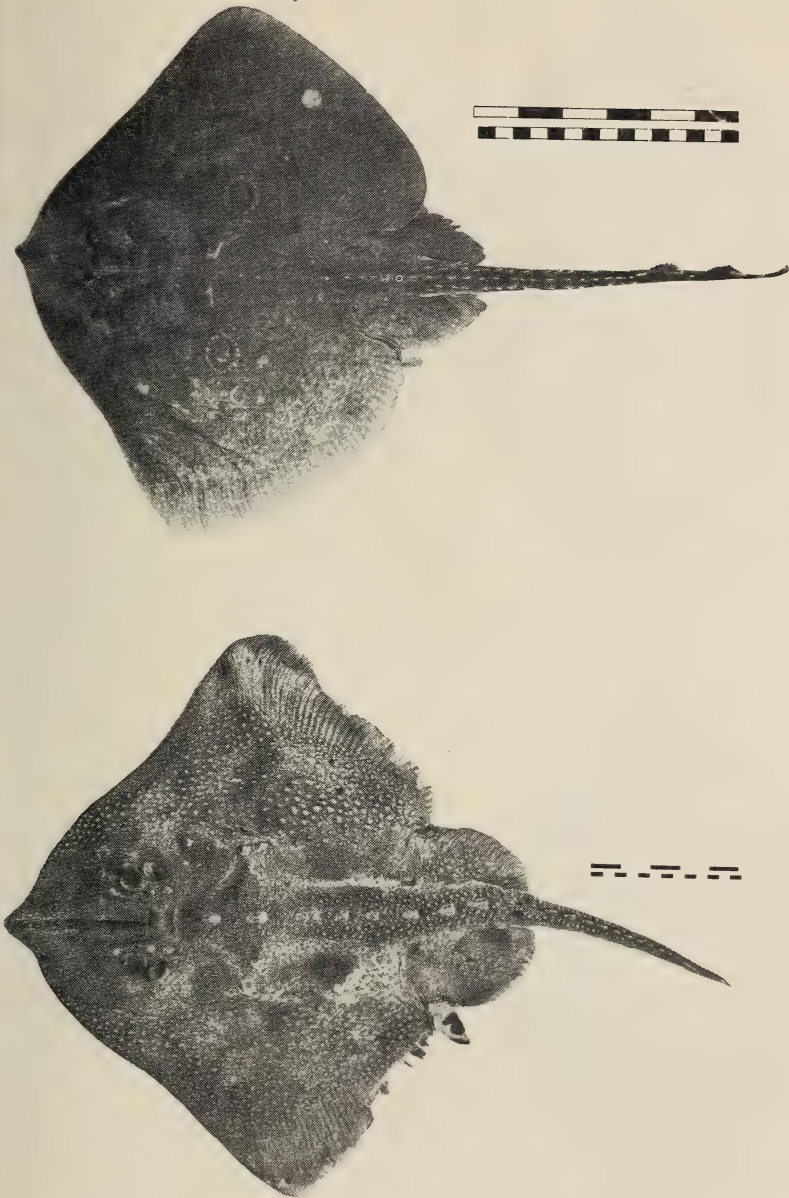


A



B

A. *R. clavata* (female). Dorsal view. Scale in cm and in. B. *B. R. straeleni* (male). Dorsal view.



A

A. *R. radiata* (juvenile male). Dorsal view. Scale in cm and in.

B

B. *R. miraletus* (female). Dorsal view. Scale in cm and in.

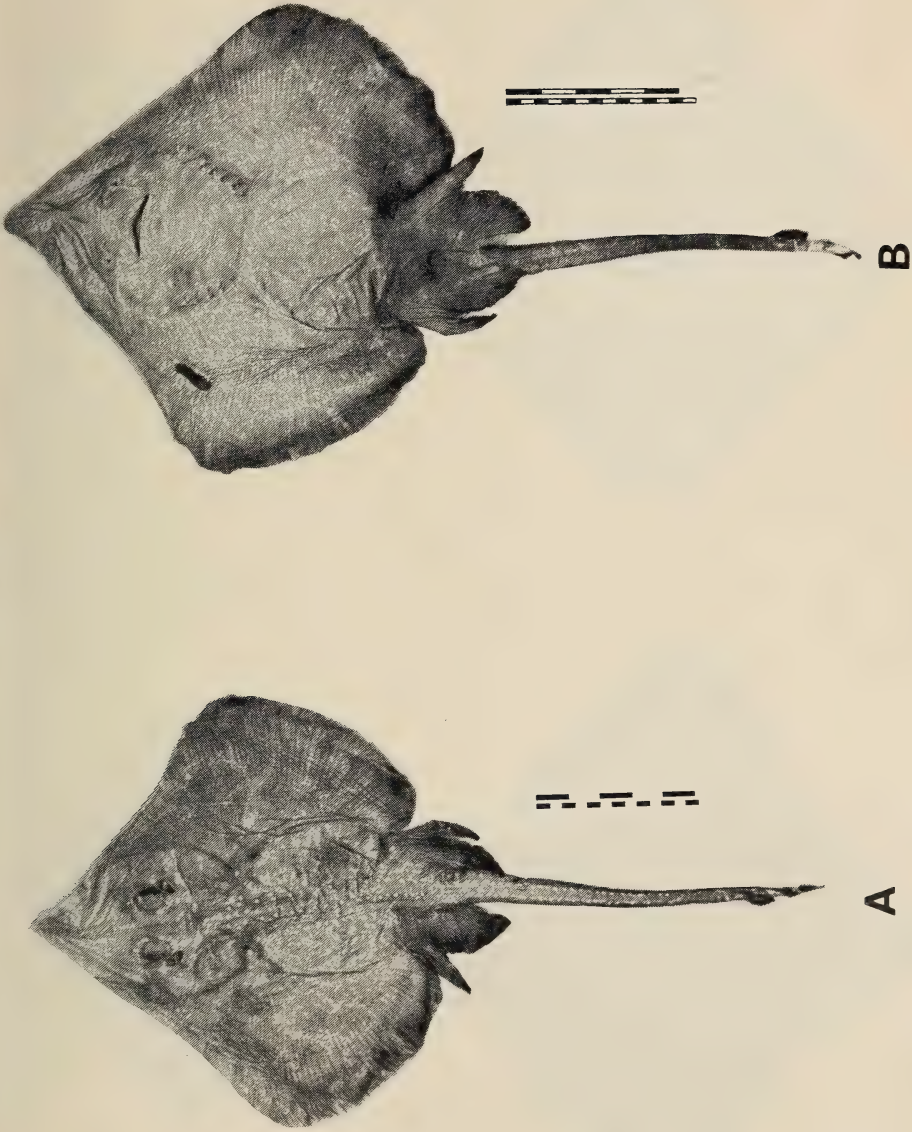


A

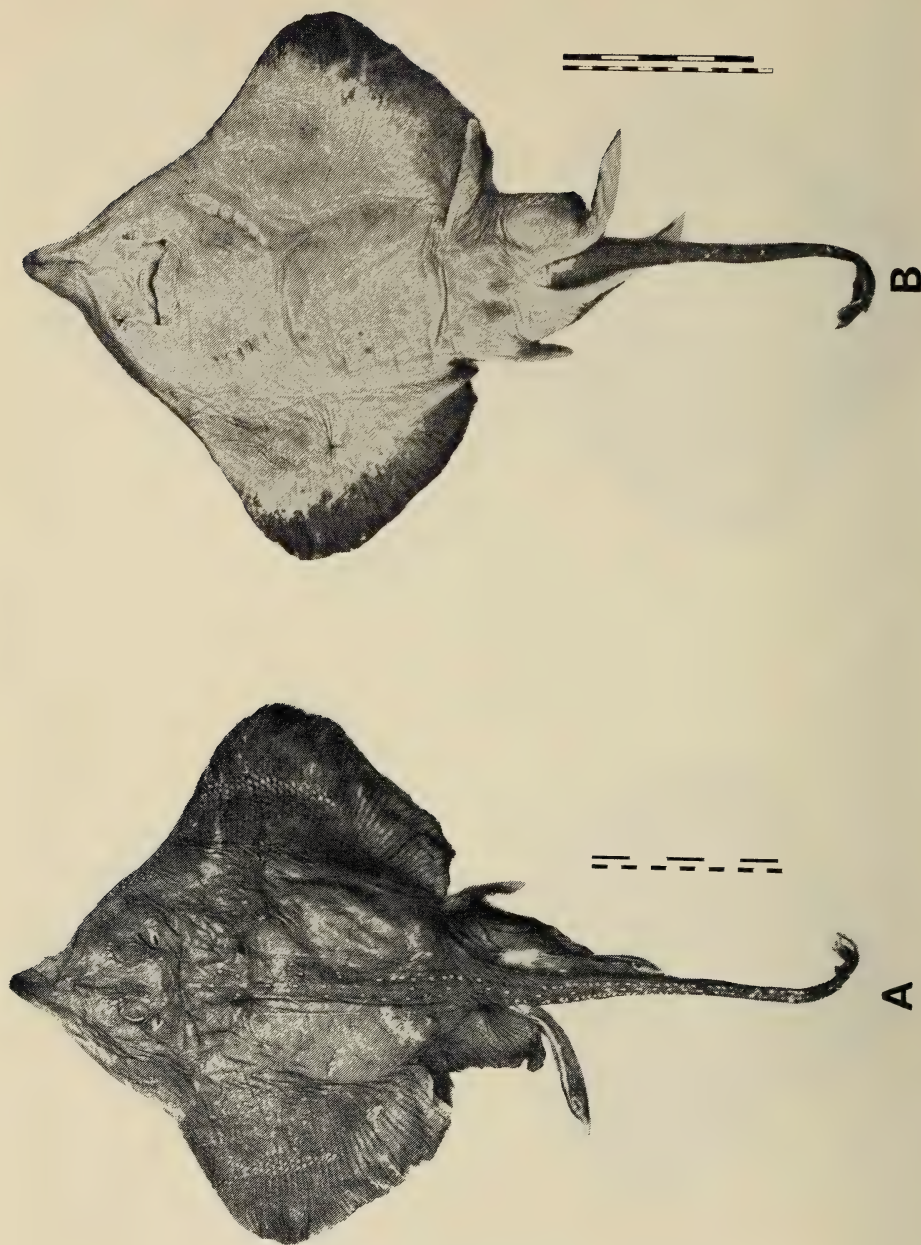


B

A. *R. robertsi*, n. sp. TYPE. Dorsal view. Scale in cm and in. B. *R. robertsi*, n. sp. TYPE. Ventral view. Scale in cm and in.



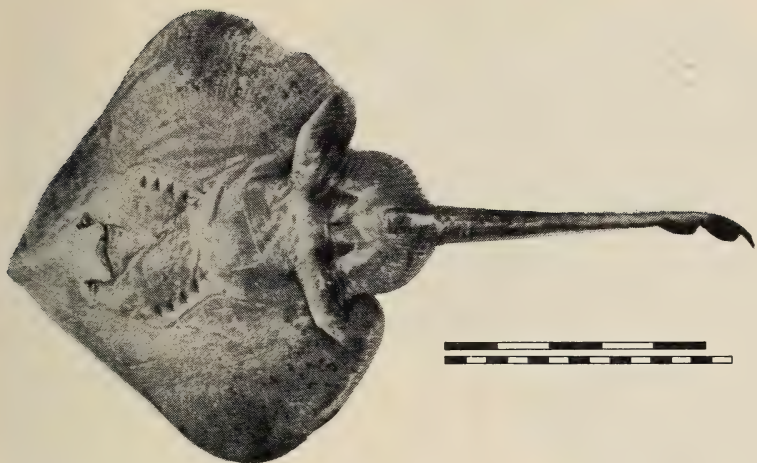
A. *R. ravidula*, n. sp. TYPE. Dorsal view. Scale in cm and in. B. *R. ravidula*, n. sp. TYPE. Ventral view. Scale in cm and in.



A. *R. dissimilis*, n. sp. TYPE. Dorsal view. Scale in cm and in. B. *R. dissimilis*, n. sp. TYPE. Ventral view. Scale in cm and in.



A



B

A. *R. confundens*, n. sp. TYPE. Dorsal view. Scale in cm and in. B. *R. confundens*, n. sp. TYPE. Ventral view. Scale in cm and in.



A. *R. leopardus* (female). Dorsal view. Scale in cm and in. B. *R. wallacei*, n. sp. TYPE. Dorsal view.



B. smithii (female). Dorsal view. Scale in cm and in.



INSTRUCTIONS TO AUTHORS

Based on

CONFERENCE OF BIOLOGICAL EDITORS, COMMITTEE ON FORM AND STYLE. 1960.

Style manual for biological journals. Washington: American Institute of Biological Sciences.

MANUSCRIPT

To be typewritten, double spaced, with good margins, arranged in the following order: (1) Heading, consisting of informative but brief title, name(s) of author(s), address(es) of author(s), number of illustrations (plates, figures, enumerated maps and tables) in the article. (2) Contents. (3) The main text, divided into principal divisions with major headings; sub-headings to be used sparingly and enumeration of headings to be avoided. (4) Summary. (5) Acknowledgements. (6) References, as below. (7) Key to lettering of figure. (8) Explanation to plates.

ILLUSTRATIONS

To be reducible to 12 cm × 18 cm (19 cm including caption). A metric scale to appear with all photographs.

REFERENCES

Harvard system (name and year) to be used: author's name and year of publication given in text; full references at the end of the article, arranged alphabetically by names, chronologically within each name, with suffixes *a*, *b*, etc. to the year for more than one paper by the same author in that year.

For books give title in italics, edition, volume number, place of publication, publisher.

For journal articles give title of article, title of journal in italics (abbreviated according to the *World list of scientific periodicals*, 4th ed. London: Butterworths, 1963), series in parentheses, volume number, part number (only if independently paged) in parentheses, pagination.

Examples (note capitalization and punctuation)

BULLOUGH, W. S. 1960. *Practical invertebrate anatomy*. 2nd ed. London: Macmillan.

FISCHER, P.-H. 1948. Données sur la résistance et de le vitalité des mollusques. *J. Conch., Paris* **88**: 100-140.

FISCHER, P.-H., DUVAL, M. & RAFFY, A. 1933. Etudes sur les échanges respiratoires des littorines. *Archs Zool. exp. gén.* **74**: 627-634.

KOHN, A. J. 1960a. Ecological notes on *Conus* (Mollusca: Gastropoda) in the Trincomalee region of Ceylon. *Ann. Mag. nat. Hist.* (13) **2**: 309-320.

KOHN, A. J. 1960b. Spawning behaviour, egg masses and larval development in *Conus* from the Indian Ocean. *Bull. Bingham oceanogr. Coll.* **17** (4): 1-51.

THIELE, J. 1910. Mollusca: B. Polyplacophora, Gastropoda marina, Bivalvia. In SCHULTZE, L., *Zoologische und anthropologische Ergebnisse einer Forschungsreise im westlichen und zentralen Süd-Afrika*. **4**: 269-270. Jena: Fischer. *Denkschr. med.-naturw. Ges. Jena* **16**: 269-270.

ZOOLOGICAL NOMENCLATURE

To be governed by the rulings of the latest *International code of zoological nomenclature* issued by the International Trust for Zoological Nomenclature (particularly articles 22 and 51). The Harvard system of reference to be used in the synonymy lists, with the full references incorporated in the list at the end of the article, and not given in contracted form in the synonymy list.

Example

Scalaria coronata Lamarck, 1816: pl. 451, figs 5 *a*, *b*; Liste: 11. Turton, 1932: 80.









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